

Making Whitworth Thread Gages¹

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SINCE the beginning of the war, the demand for thread gages has increased greatly owing to their use in the manufacture of munitions; consequently many concerns that were in a position to handle this kind of work began to make thread gages, and as some of these manufacturers who had little or no experience in gage making were obliged to do more or less experimenting, a large number of inaccurate gages was the natural result, especially where certain well established principles of gage making were not followed. In this article the methods and general practice which have proved satisfactory in the production of accurate thread gages will be described, and as the Whitworth thread presents the greatest number of difficulties, the important features connected with the making of this form of gage will be considered in detail. The different operations will be taken up in the order in which they follow in actually making a gage and will include methods of machining the gage blank, grinding and lapping the thread, heat-treating processes that are essential at different stages of the work, and the final inspection of the gage to insure that it is up to the required standard of accuracy. While much of the general practice described may be applied to the making of any thread gage, a specific example of gage making has been selected in order to enable the subject to be presented in a more definite manner. The gage selected as an example is illustrated in Fig. 2. This is a sectional form of gage, consisting of a handle *A*, disk *B* (for testing the angle of a conical seat when the gage is inserted in the work), threaded shell or gage proper *C*, screw *D* for holding the various parts together, and dowel-pin *E*. The gage thread has two flutes or "dirt grooves" *F*, which are slightly

The Whitworth screw thread having an included angle of 55 degrees and a rounded crest and root is specified for British munitions. Thousands of Whitworth thread gages have been made for use in the manufacture and inspection of the enormous number of guns and shells that have been manufactured here during the past three years. As a result this branch of gage making has become highly specialized and methods have been developed for producing highly accurate gages at comparatively low labor cost. This article reviews the practice followed by one successful gage manufacturer. It includes the selection and preliminary treatment of the steel, and the operations are described step by step. The latter include machining the blanks, preliminary annealing, rough-threading, carburizing, finish-threading, hardening, grinding, selection of wheels for grinding, shaping the wheel, lapping, wire measurement, final heat-treatment and hardness testing.

deeper than the thread and extend across it to form edges that will scrape off any dirt that may be in the thread to be tested. As it is the object of this article to deal principally with the production of an accurate thread on a gage of this kind, only the operations on part *C* will be considered.

Whitworth Standard Screw Thread

In order to avoid misunderstanding in regard to the different terms used throughout this article, these will be defined at the outset and specifications for the Whitworth standard thread will also be given. The Whitworth thread consists essentially of three parts, namely, the top or crest of the thread (see Fig. 3), the sides or slope of the thread, and the root or bottom of the thread. The top and root are rounded to a curvature that corresponds to an arc having a radius *r* equal to 0.137329 times the pitch of the thread. The radius for the top of any given pitch of thread may be found accurately enough for practical purposes by dividing 0.1373 by the number of threads per inch. For example, if there are 14 threads per inch, the radius of the top and bottom of the thread = $0.1373 \div 14 = 0.0098$ inch. The angle between the sides of the thread measured in an axial plane is 55 degrees. The depth of the thread or distance from the top to the bottom measured in a line perpendicular to the axis of the gage is equivalent to the pitch $\times 0.640327$ or $0.640327 \div$ number of threads per inch. To avoid confusion in specifying dimensions, the following names will be used:

Full Diameter: The full diameter *F* is the outside diameter, and is the distance across the highest points of the threads.

Effective Diameter: The effective diameter *E* (of a screw having a single thread) is the distance between the points at which a line drawn through the center of the gage perpendicular to its axis intersects the sides of the thread and is equivalent to the full diameter minus the depth of one thread.

Nominal Core Diameter: The nominal core diameter *C* or the root diameter is equal to the distance across the lowest

¹For information on making thread gages previously published in MACHINERY, see "Master Whitworth Thread Gages" and "Production of Accurate Thread Gages," in the September, 1917, number.

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points of the thread groove measured in a line perpendicular to the axis of the thread, when the latter is of standard depth. The actual core diameter of the gage shown in Fig. 2 is made from 0.001 to 0.002 inch less than the nominal core diameter. The full diameter may vary from 1.997 to 1.9973 inch, and the effective diameter may vary from 1.9513 to 1.9516 inch. The nominal core diameter is 1.9056 inch and the actual core diameter may vary from 1.9036 to 1.9046 inch. There is a tolerance of 0.0003 plus or minus in the lead of the gage thread, but it is advisable to reduce the lead error as much as possible. In spite of the greatest precautions, however, in cutting laps accurately in lead and grinding gages accurately, slight lead errors are usually found. If a gage is out 0.0001 inch in lead, it is necessary to make it approximately 0.00016 inch smaller than a gage that has a perfect lead to make it enter the same master gage. This means that if there is a plus tolerance of 0.0003 and a female master is set to fit a gage having a perfect lead that is plus 0.0003 in effective diameter, another gage that has an error in lead of 0.0001 inch would have to be 0.00016 inch smaller on the effective diameter in order to enter the same master gage.

Steel for Thread Gages

Machine steel containing 0.50 per cent carbon and pack-hardened is generally specified for making thread gages. In practice, it has been found that any good grade of machine steel of even or homogeneous grain, free from flaws or fissures, will produce a good thread gage if given the proper heat-treatment. Some fissures occur in machine steel that cannot be detected readily until after a gage has been hardened and is being ground. Therefore, it is advisable before cutting up a bar and machining it into gage blanks to cut a disk about 1/4 inch thick from the center of the bar and examine it carefully. If no flaws or fissures can be detected with the naked eye or a magnifying glass, drill a hole in the center, take a cut over the outside, carburize and quench the piece. Then grind and lap the side and top, and if no defects or flaws are visible, fracture the sample and examine the case and core carefully. If the metal appears to be perfect, it is safe to use the bar. All bar ends should be discarded, and it is also necessary to use a bar that is 3/16 inch larger in diameter than the finished gage in order to avoid all surface cracks.

Machining Gage Blanks

After the proper material has been selected and tested, if the number of gage blanks is large enough to warrant it, the blanks may be machined in a turret lathe or automatic. A roughing cut is taken over the outside, the bar faced off, a hole drilled and reamed about 0.005 or 0.006 inch under size and the blank cut off about 3/32 inch longer than specified. If a rigid engine lathe is the best machine available, one end of a bar of sufficient length should be held in the chuck, while the other end is supported in the steadyrest. The bar is then centered at this end, and after the tailstock is brought up to

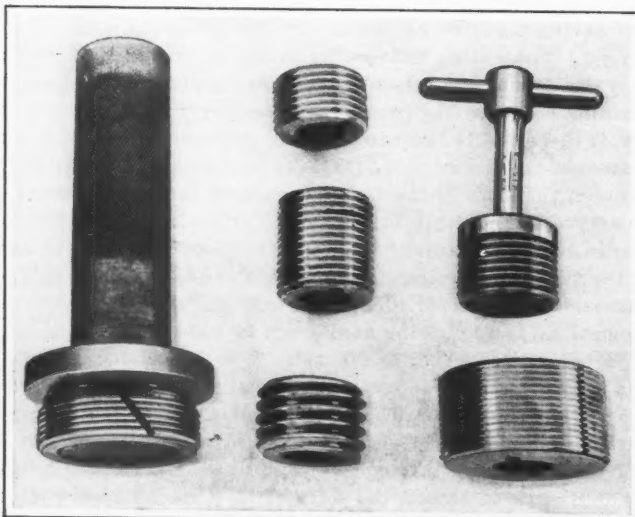


Fig. 1. Group of Whitworth Thread Gages made for testing Threads in Shells

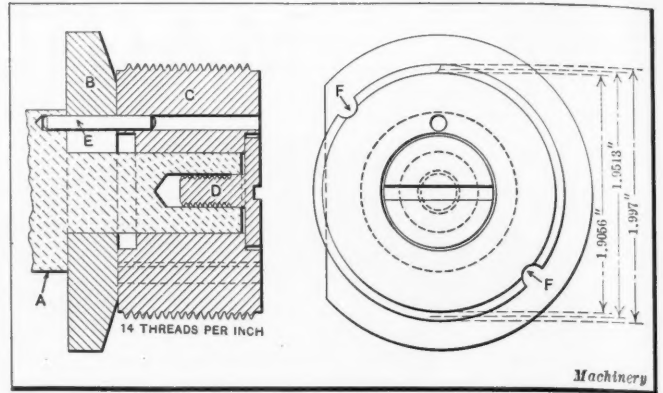


Fig. 2. Whitworth Thread Gage

support the bar, a cut is taken over the outside. The steady-rest is next adjusted to the turned surface and a hole is drilled and reamed and the blanks cut off. The bar should extend far enough to allow about six blanks to be cut from it, assuming that a number of gages are to be made.

If a rigid lathe is not available, the blanks may be cut off about one-eighth inch longer than required, in a hacksaw machine. They are then placed in a chuck, faced off, and center-drilled and reamed. The blanks are next driven on an arbor placed between centers and a roughing cut is taken over the outside and the other face.

Preliminary Annealing Process

After the blanks have been rough-machined all over, sufficient material has been removed to disturb the internal strains in the metal and leave it in an unbalanced state. In order to avoid warping of the metal as much as possible during the subsequent rough-machining and carburizing, the blanks are now placed in a gas furnace, such as can be found in almost any machine shop or tool-room, and are heated slowly to a temperature of 1450 to 1550 degrees F.; they should be kept at this temperature about one hour to allow them to become thoroughly saturated or evenly heated. The blanks are then taken out and buried in a mixture of sawdust and lime and allowed to remain there until cold. This is practically a short annealing process, and if this heat-treatment is omitted, it will be found, after finish-machining and pack-hardening, that a large percentage of the blanks will not "clean up" in grinding, owing to the distortion and warping that takes place in carburizing and hardening.

Reaming and Counterboring

When the blanks are removed from the annealing mixture, the holes are cleaned of scale and reamed out to within 0.001 inch of size with a machine or hand reamer. They are then taken to a drill press and are counterbored deep enough to allow for facing off the surplus stock on the sides or faces. Counterboring before facing off makes it possible to face off the blanks on an arbor without digging into it or injuring the point of the tool. They are then driven on an arbor and are turned off on the outside 0.012 inch over size and are faced off on the sides, leaving about 0.020 inch on a side. The holes for the key pins are next spotted with a jig, which is then removed and each hole drilled about 0.010 inch larger than the key pin to allow for the change that takes place in the size and position of the hole during carburizing and hardening.

Rough-machining the Thread

The thread on the blank can be roughed out on any lathe having a fairly accurate lead-screw and a tool of the proper shape. The compound rest of the lathe should be set to an angle of 27½ degrees with the axis of the work, allowing the tool to cut on one side only, so that the point will not be subjected to the strain which is caused by the crowding of the chips when the tool is cutting on both sides.

A simple and inexpensive thread milling fixture that has been used for this work in conjunction with a hand milling machine is shown in Fig. 4. This fixture consists essentially of a base A, which is machined and slotted at J for lining up the front and back bearings C and E which carry shaft B.

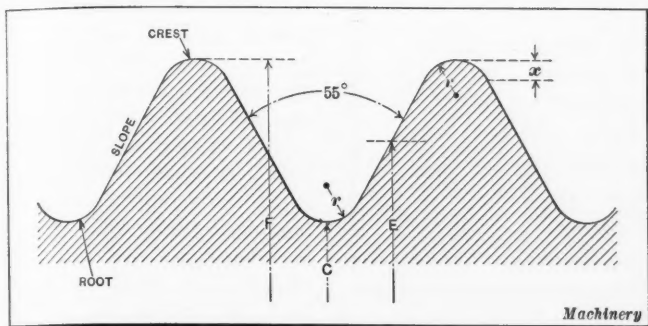


Fig. 3. Section of Whitworth Standard Thread

Bearing *C* is babbitted with *B* in position, so that the babbitt surrounds the threaded portions of *B*, which is cut on a fairly accurate lathe to the same pitch as the gage. Bearing *E* is bored out to a snug fit for the straight bearing on shaft *B*. A train of gears *F* from pulley *H* to shaft *B* reduces the speed to about 6 inches surface travel of the work per minute. The fixture is constructed so that gears from a lathe may be used. Shaft *B* is machined off square on end *G* to fit the handle of the milling machine for a quick hand return movement. The fixture is set to align the cutter with the helix angle of the thread. After a thread has been milled on the blank *D*, the belt is thrown onto the idler pulley and the shaft is returned to its original position by turning it backward with a handle placed on the squared end *G*. This operation is repeated until all the gage blank threads have been milled. The form of cutter shown at *K* is next removed and a cutter of the kind illustrated at *L* is placed on the arbor. This cutter is then used to mill away the end threads up to the point where a full thread begins. This operation leaves the gage 0.025 inch over size on the effective diameter and 0.008 inch under the core diameter on the reduced end threads.

Carburizing the Threaded Blanks

For carburizing the threaded blanks, any good gas furnace may be used which has a heating chamber that will receive a pot sufficiently large to provide room for an inch and a half of carburizing material all around the blanks. A cast-iron pot having a heavy cover will be satisfactory. The material for carburizing can be granulated raw bone or any other good carburizing agent or compound that is certain to give good results. It is well to avoid using materials that penetrate too rapidly for carburizing thread gages, as too rapid penetration causes excessive movement in the structure of the metal and results in an unusual distortion of the thread. A mixture of equal parts of granulated raw bone, charred bone, and used bone that has not been decarburized sufficiently to render it practically useless as a carburizing agent, has given excellent results, as the rate of penetration is not too rapid and the amount of phosphorus contained in the mixture is not excessive. A high percentage of phosphorus tends to cause great brittleness in hardened steel. There are a number of case-hardening and carburizing compounds on the market that have given very good results, but for anyone who endeavors to pack-harden a gage for the first time, bone is the safest to use.

In packing the threaded blanks in the pot, the bottom should be covered to a depth of at least $1\frac{1}{4}$ inch with carburizing material, and the pieces to be carburized should be laid upon it, leaving at least one inch of space for material between them. The spaces between the pieces and the pot walls should be filled in and packed tightly, using a thin wooden stick to tamp with, thus allowing the material to fill up all the spaces and the pieces to settle about $\frac{1}{4}$ inch deeper in the bone. The pot is then filled up to the top and tamped down solidly, more material being added until the carburizing agent is packed firmly to the top of the pot. There should be a space of about $1\frac{1}{4}$ inch above the gage blanks for the carburizing material. The cover is luted carefully all around the edges

of the pot and covered with moistened fireclay. The pot is then put in the furnace and allowed to heat gradually until its entire contents have reached a temperature of from 1750 to 1800 degrees F. This temperature should be maintained for at least six hours. The pot is then allowed to cool as slowly as possible. It is preferable to allow the pot to remain in the furnace over night and cool in it, as the furnace and pot will retain the heat for a considerable length of time, and allow the process of penetration to continue. If this method of cooling is not followed, the gages are likely to have an excessive amount of carbon near the surface, giving them a tendency to chip; therefore, under no conditions should the blanks be removed from the pot until they are thoroughly cooled.

After removing the blanks from the carburizing pot, inspection will show that the hole in the blank is closed in from 0.003 to 0.004 inch during carburization and cooling, and it is necessary to again ream the hole to within 0.001 inch of size. The blanks are then replaced on an arbor and the sides faced, leaving about 0.008 to 0.010 inch on a side for grinding. This facing is necessary to make the sides square with the hole.

Finish-machining after Carburizing

A light finishing cut is next taken over the threaded part of the gage. This can be done with an accurate lathe having a tested lead-screw. The gage blank is placed on an arbor held between the centers and a finishing cut is taken, preferably with a gooseneck tool-holder carrying a tool ground and lapped to fairly accurate form. The effective diameter of the thread is finished to within 0.012 inch of size. Instead of using a lathe, the finishing cut may be taken with a milling cutter, the milling fixture shown in Fig. 4 being employed. The dirt grooves are now milled on an ordinary milling machine. A $1/16$ -inch radius cutter is used, and the grooves are milled at least 0.015 inch below the root of the gage thread. These grooves were formerly made helical, but are now milled parallel with the gage axis (see Fig. 1).

Finish-machining after carburizing is necessary to reduce the number of defective blanks to a minimum. If the blanks are finish-machined before carburizing, the complete change in the molecular structure of the metal during the process of carburizing will cause such distortion of the thread that an allowance of 0.015 inch for grinding is scarcely sufficient, and many blanks will not "clean up" in spots. Moreover, if the hole is not reamed to size after carburizing and the blank is immediately quenched after taking it out of the furnace, the hole will close in from 0.008 to 0.010 inch, thus leaving an excessive amount to be lapped out and making it almost impossible to lap the hole true with the axis of the thread except with an excessive expenditure of time and labor.

Hardening Gage Blanks

The blanks are now ready for hardening. They should again be placed in a pot and decarburized bone should be packed all around them in the same manner as in carburizing. The cover is then put on, packed and sealed with moistened fireclay. The pot is then placed in the furnace and heated slowly until the entire contents reach a temperature of 1550 degrees F. This temperature is maintained about thirty minutes, allowing the work to become thoroughly saturated. The pot is then taken

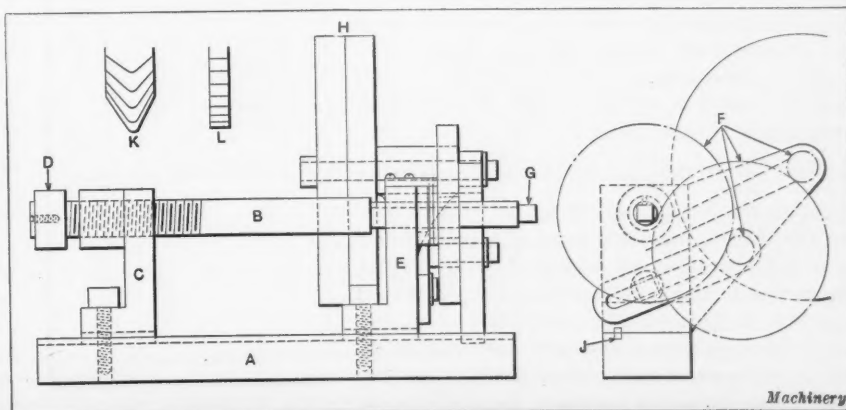


Fig. 4. Special Machine or Attachment used for milling Threads on Gages

from the furnace, the cover removed and the blanks quenched. This can be done by taking the blanks out of the pot one by one and quenching them, but a better way is to dump the entire contents of the pot into the bath. The latter should have a sieve or net suspended in it, and a free circulation of running water entering from the bottom. When the blanks have been dumped into the sieve, the latter should be moved up and down to allow the blanks to be cooled off rapidly and evenly. The latter method has the advantage of quenching all blanks at the same heat, thus insuring a uniform degree of hardness and avoiding the scale that forms when the blanks are carried through the air before immersing in the bath.

The blanks are taken from the bath when cool and placed in a pot containing a solution of water and washing soda, in which they are boiled for about ten minutes; they are then removed and allowed to cool. This is really a light tempering or "letting down" process and prevents excessive brittleness, or, in the vernacular of the toolmaker, it takes the "snap" out of them. This light tempering should be done immediately after taking the blanks out of the quenching bath.

Lapping Hole in Gage

The hole is now ready to be lapped. When this is done, the blank should be held in the hand (using a piece of emery cloth or old leather belting to protect the hand from injury) and the lap should be held in the chuck of a lathe or drilling machine. This allows the lap to follow the hole and insures finishing the hole fairly accurately with reference to the thread. It is well to see that the hole cleans up evenly all around as it is gradually lapped out. The hole, previous to lapping, will be found considerably bell-mouthed, and may be about 0.002 inch under size at the ends and about 0.004 inch under size at the center of the blank. It can readily be seen that if a blank is held in a vise in the drill press, or is confined in a similar manner, there is serious danger of lapping the hole out of true with the axis of the thread. Two different forms of laps are shown in Fig. 5. The split lap shown at B should be used for roughing, as it allows of rapid and easy adjustment and removes the stock rapidly. The lap shown at A should be used for finishing, as it keeps the hole straight and round. The abrasive used for lapping may be Turkish or Chester emery (grade F), as it is tough and sharp, and if applied properly, will charge satisfactorily and lap out the hole without much wear of the lap. The lap should be adjusted lightly to the work—just enough to make the abrasive cut well—for if the lap grips too tightly, all the emery will be crowded out and the operation will be greatly lengthened. The hole in the gage shown in Fig. 2 should be lapped out until a 0.625-inch standard plug passes through it. The blank is now driven on a perfectly true arbor and is placed between the centers of a universal grinder or bench lathe and both faces are ground just enough to true them. The blank is then ground on the outside or full diameter until it is from 0.003 to 0.004 inch over size.

Advantages of Grinding Thread before Lapping

Before taking up the subject of rough-grinding the thread, the advantages of a preliminary grinding operation as compared with lapping the thread to size will be considered. A thread that is to be finished after hardening by lapping alone must be very accurately machined in order to leave as little stock as possible for lapping. This threading operation generally takes three times longer than when cutting the thread

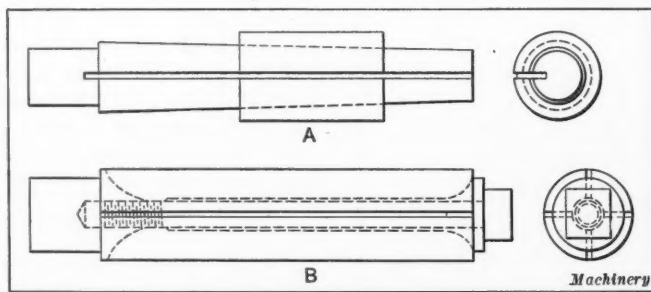


Fig. 5. Two Forms of Laps used for lapping Holes in Thread Gages

stock can be removed in this way much more rapidly than the smaller amount left for lapping. The amount of stock left for grinding also insures that all threads will clean up when reduced to the finish size.

Another great advantage of grinding threads is that they can be finished within 0.0004 or 0.0005 inch of size on the effective and full diameters, and the core diameter can be ground right down to size, leaving just enough to remove the slight wheel marks and lap the thread to a high finish. As threads are ground extremely accurate as to form and lead, two or three laps for the angle or slope of the thread, one for the crest and another for the root are all that are required, because, as the angle and lead are accurately ground, the laps will continue wearing accurately and will need little correction. On the other hand, if the thread is finished exclusively by lapping, a number of laps will be required for roughing and finishing, because the thread, after hardening, is distorted and inaccurate as to lead, thus requiring continual correcting and renewal of laps, especially where many thread gages are made. Making thread laps is an accurate and tedious job and may greatly increase the cost of production.

Special Thread-grinding Machine

Thread grinding can be done on a lathe having an accurate lead-screw and equipped with a grinding attachment mounted on the cross-slide. Better results can be obtained, however, with a special thread-grinding machine similar to the one shown in Fig. 7. This machine has a cast-iron base C upon which is mounted the frame for supporting shaft X. This shaft carries three pulleys. The outer pulleys are loose and the central one tight on the shaft. Two bearing brackets A and B support the master screw shaft E, upon the outer end of which is mounted the gage G to be ground. The cross-slide D carries spindle F and grinding wheel R. The wheel-spindle may be adjusted to locate the wheel in line with the thread. The belt pulleys for driving the master screw E should be so proportioned that the gage will have a surface speed of about 40 feet per minute. The surface speed of the grinding wheel should be about 8000 feet per minute, unless a lack of balance in the wheel or other conditions make it unsafe to revolve the wheel so rapidly.

When this machine is in operation, the master screw E is revolved in first one direction and then the other by means of open and cross belts, which are alternately shifted onto the central or tight pulley Q. The drive from the pulley shaft to the master screw is through faceplate Y, stud Z and a dog W. The threaded section of the master screw E passes through a babbitted bearing in the bracket A. This screw must be cut in a precision lathe that has been thoroughly tested for accuracy or one that is equipped with some device that will compensate for slight errors in the lead-screw. The spindle of the grinding machine is driven from a bench motor by a belt running over the grooved pulley shown at the right-hand end of the spindle. When the machine is first started, shaft E travels forward and the grinding wheel is adjusted in a lengthwise direction until it is in alignment with the thread groove. After shaft E

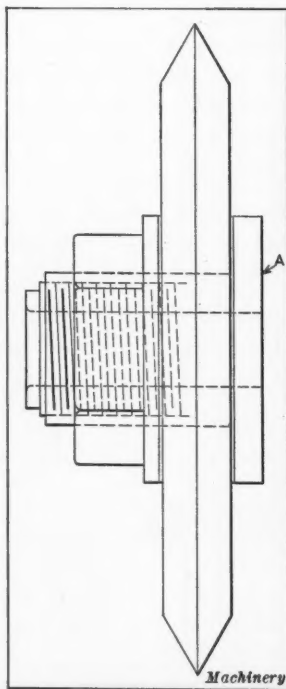


Fig. 6. Method of mounting Grinding Wheel to insure Accuracy and reduce Dressing

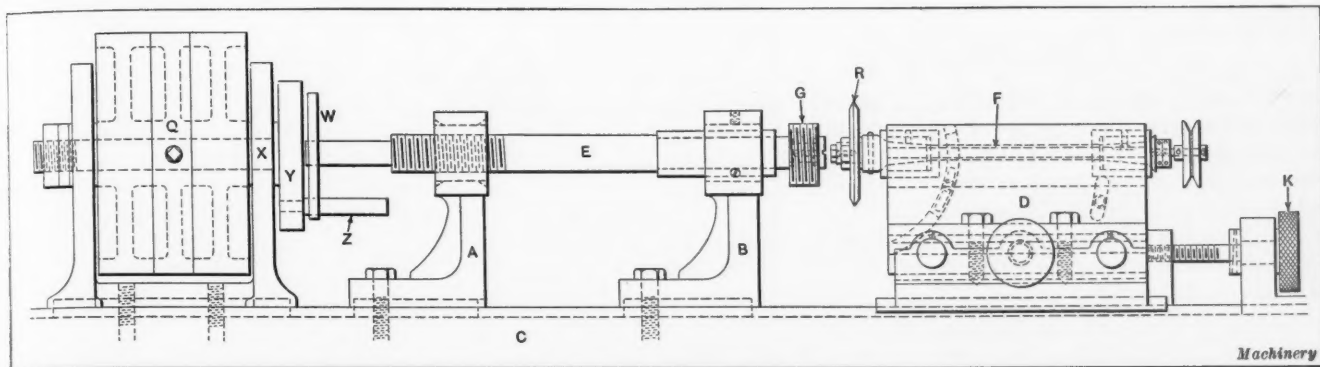


Fig. 7. Special Machine used for grinding Gage Threads Preparatory to Lapping Operation

has made a certain number of turns, the gage is carried past the grinding wheel and then the rotation of shaft *E* is reversed by shifting the belt; the gage then traverses past the grinding wheel in the opposite direction, so that the machine is grinding almost continuously and is more rapid in its operation than a machine arranged to grind in one direction only. The gages ground on this machine are duplicates of the master screw, so far as the lead of the thread is concerned.

Wheels Used for Thread Grinding

The grain of the wheel used for grinding thread gages should be fine enough to allow the wheel to be dressed to a point or edge sufficiently sharp to meet the necessary requirements. The abrasive should be free-cutting and the bond sufficiently tough to prevent the edge of the wheel from crumbling too rapidly, but not so hard as to retain the abrasive long enough for the wheel to become glazed. Alundum wheels of 120 grain, grade J, and 120 grain, grade K, have proved satisfactory for thread-gage grinding. The 120 J wheel is suited for rough-grinding and the 120 K wheel may be used either for roughing or finishing, but is best adapted for finishing. Another grinding wheel that is giving satisfactory results for roughing is a 180 M aloxite wheel. If the threads on the gage are coarser than 12 per inch, a 120 J alundum wheel may be used for finishing. If the threads are finer than 16 per inch, a 200 M alundum wheel should preferably be used.

The grinding wheels used for this work should be mounted permanently on bushings as shown in Fig. 6. The face *A* of this bushing that comes into contact with the ground shoulder of the wheel-spindle is finished square and true with the hole; consequently, when the wheel is placed on the grinding machine spindle, it will always run true and be in the same position relative to the master screw.

Adjustment of Grinding Wheel

When adjusting the grinding wheel so that the working side is in line with the helix angle of the thread, the angle of the helix may be determined as follows: Multiply the full diameter of the gage by 3.14 and divide the pitch by the result. Then find in a table of natural tangents the angle having a tangent that corresponds to the quotient. For example, if the full diameter is 2 inches and there are 10 threads to the inch, the pitch is 0.100.

$$2 \times 3.14 = 6.28$$

$$0.100 \div 6.28 = 0.0159$$

The corresponding angle is about 55 minutes, which is the amount the wheel should be inclined from the vertical. After the wheel has been set to the required angle, it is dressed to an angle of 55 degrees when measured in a plane intersecting the axes of the gage to be ground, and the edge or apex of the wheel is left sharp. The diamond is mounted in a block held in the hand, and it is guided by

the dressing fixture shown in the plan view Fig. 8. The plate *A* of this fixture has two grooves in the form of the letter X, which incline 55 degrees relative to each other. The block *B* carrying the diamond tool *C* is pushed through first one groove and then the other when truing the wheel. The plate *A* is supported upon two brackets (only one is shown), each containing two guide-pins *D* which engage slots in the plate and hold it in position when in use. The diamond *C* is located at the same height as the grinding wheel center. The slope or angular sides of the thread are now ground by using the machine shown in Fig. 7. The wheel is set central with the thread groove and the grinding is continued until the thread has been ground true, so that a measurement can be taken. The means used for measuring the full diameter, effective diameter, the angle of the thread and the core diameter will now be described.

Use of Wires for Measuring Effective Diameter

The effective diameter can be measured with a thread micrometer, but as this tool has only a limited range as to size and number of pitches it can measure, it may be desirable or necessary to check up the angle and effective diameter by using an ordinary micrometer and two or more sets of different size wires. When measuring the effective diameter by the wire method, there should be two wires on one side of the thread and one on the opposite side, as illustrated by diagrams *A* and *B*, Fig. 9. The two wires on one side should be spaced as far apart as is practicable. In some cases, if the thread is of fairly coarse pitch, it may be necessary to place the wires in adjacent thread grooves, as illustrated by the full and dotted lines at *a* and *c*, whereas, for a thread of finer pitch, the wires may be spaced farther apart, as at *a* and *b*.

Table 1 gives the sizes of wires to be used for checking up Whitworth threads of different pitches and the amount to add to the full diameter when using a wire of given size. The smallest and largest wires that can be used conveniently with ordinary micrometer calipers are listed in the table. In applying the table to the gage shown in Fig. 2, which has 14 threads per inch, we see that the first number under "Threads per Inch," in the column headed 14, is the decimal 0.00437. This is the amount to be added to the outside or full diameter 1.997 to obtain the measurement over wires 0.0375 inch in diameter, which is the size of wire in the column to the left and on the same line with the decimal 0.00437. This is the smallest wire to be used for measuring 14 threads per inch. The last decimal in the column under 14 is 0.05977, which is the amount to be added to the full diameter when using wires 0.055 inch in diameter—the largest wires to be used for measuring 14 threads per inch. The distance over the wires or the micrometer reading equals:

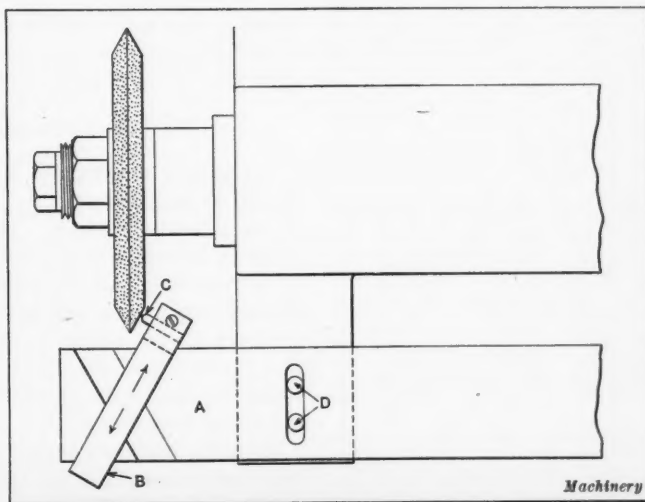


Fig. 8. Fixture for dressing Sides of Wheel to Angle of Gage Thread

$$\text{Full diameter} - \frac{1.6008}{\text{number of threads per inch}} + (3.1657 \times \text{wire diameter})$$

This formula expressed as a rule is as follows: Divide the constant 1.6008 by the number of threads per inch; subtract the quotient from the full diameter and add to the difference 3.1657 times the wire diameter. The result equals the micrometer reading or the measurement over the wires.

The difference between the distance over the wires and the full diameter represents the dimensions given in Table 1 for various pitches and sizes of wires. It may not always be convenient or advisable to use wires corresponding to the diameters given in the table. For instance, it may be preferable to use wires that are 0.0385 inch in diameter instead of 0.0375-inch wires, which is the minimum size for 14 threads per inch. In that case, multiply the difference between 0.0385 and 0.0375 by 3.1657 and add this product to the dimension given in the table for the 0.0375-inch wires to obtain the distance over 0.0385-inch wires.

The multiples of 3.1657 at the lower part of Table 1 are convenient to use when figuring dimensions over wires. Suppose wires that are being lapped down to 0.0375 inch are perfectly round at 0.0381 inch. It would be inadvisable and a waste of time to lap them to 0.0375 inch. The difference between 0.0381 and 0.0375 is 0.0006; therefore, in order to get the dimension over 0.0381-inch wires, take the number 18.9942, which is six times 3.1657, from the table of multiples, and move the decimal point four places to the left, which makes the number 0.00189942 and is the same as multiplying 3.1657 times 0.0006. Add the result to the value given in the table for 0.0375-inch wires to obtain the amount to be added to the outside diameter of the gage when using wires 0.0381 inch in diameter. For instance, if 2.00137 equals the measurement over 0.0375-inch wires, $2.00137 + 0.001899 = 2.00327$ equals the distance over 0.0381-inch wires. If wires become worn or are under size, the distance over them can be figured in the same way by subtracting the difference instead of adding.

Measuring Core Diameter

The core diameter of the gage can be checked by using the triangular wedges as shown at C, in Fig. 9. (See also the detail

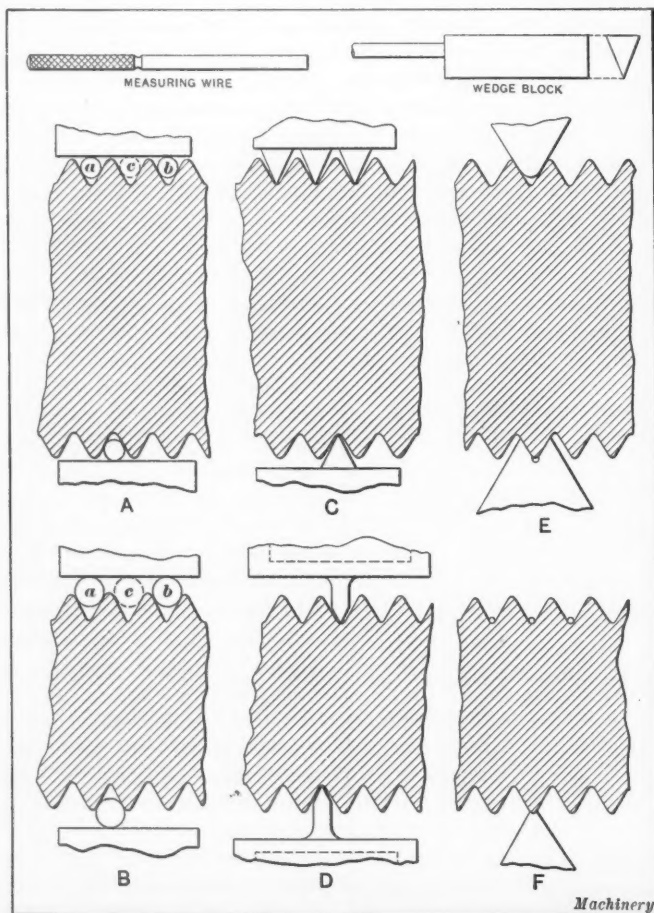


Fig. 9. Methods of measuring Diameter of Gage Thread

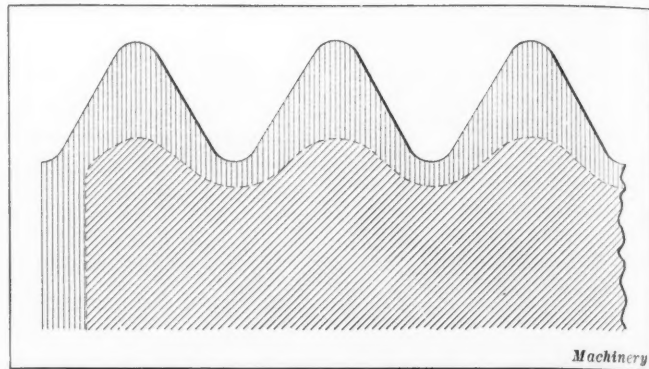


Fig. 10. Diagram showing Depth to which Thread Gage is carburized and hardened

view at the upper part of the illustration). When measuring with these wedges, twice their height should be subtracted from the micrometer reading in order to obtain the core diameter. Micrometer points, such as are shown at D, can also be used for checking the core diameter. These points are so made that they can be removed from the anvil and spindle of the micrometer, and they are more convenient to use than the wedge blocks in roughing. With micrometer points, a hardened plug should be ground down to a diameter corresponding to the size of the core diameter and the micrometer points set from it. The use of a thread micrometer is illustrated at E, and at F are shown methods of testing the radius of the root and crest. A wire of the correct radius is laid in the root, and a templet is used for the crest.

When measuring the diameter with wires, rubber bands are sometimes placed over each end of the wires to hold them in place, but this is not good practice, as the rubbers cramp the wires and make it impossible to obtain a good measurement with the micrometer. To use the wires properly, two should be placed in the threads, the micrometer opened about 0.010 or 0.015 inch more than the probable measurement over the wires, and the spindle brought down on them in such a manner as to hold them in place. The third wire is then slipped in between the anvil and the lower thread groove; the micrometer is then adjusted until it just holds the wires and a reading is taken. In measuring the angle and effective diameter of the thread while grinding, three sets of different size wires should be used. Assuming that the gage has 14 threads per inch, as in this particular case, the 0.0375-inch, 0.040-inch and 0.055-inch wires should be employed. As 0.003 or 0.004 inch has been left on the full diameter for finish-grinding, and wires 0.0375 inch in diameter only extend 0.00437 inch beyond the full diameter, the larger wires should be used until the full diameter is ground nearly to size. The wedge blocks for measuring the root are inserted and held in the thread groove the same as wires.

After rough-grinding the gage sufficiently to true it, a measurement will usually show that the amount of stock left for finishing has been reduced from 0.004 to 0.005 inch, leaving approximately 0.007 or 0.008 inch on the effective diameter and usually 0.008 to 0.009 inch on the core diameter. The wheel is now redressed to a sharp vee as before, and the root is ground until the relation between the root and effective diameter is right and the size is plus 0.003 or 0.004 inch.

Heat-treatment to Prevent Subsequent Distortion of Gage

The gage is now passed through another heat-treatment consisting of an immersion in boiling soda water for a period of at least thirty minutes. This is absolutely necessary, especially at this stage of the work. The remainder of the material to be removed from the gage by machining or lapping is extremely slight, and the precautions to be taken to insure a permanent set of metal and to eliminate as much as possible any likelihood of distortion of the gage after it is completed, makes it absolutely necessary for it to be subjected to this additional heat-treatment.

Since the gage has passed through the hardening, there has been approximately 0.008 inch of stock removed from almost all the surfaces. This removal has reduced the case or binder of the gage sufficiently to affect its interior structure in such

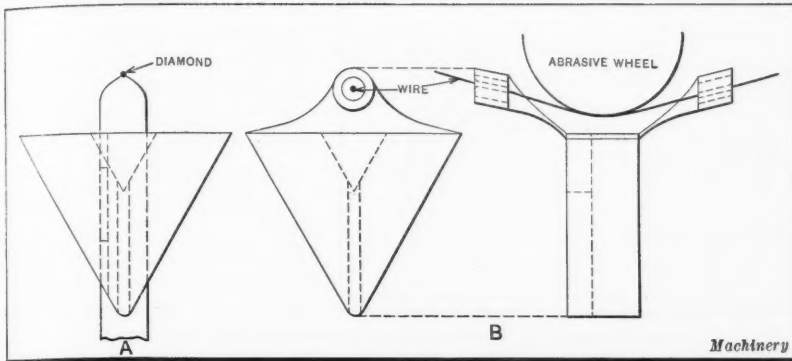


Fig. 11. Equipment for forming Concave Groove in Periphery of Wheel for grinding Crest of Gage Thread

a way as to cause it to shrink in some spots. As it is impossible for the gage to assume immediately the shape which it tends to take as the result of the strains caused by the removal of metal, this change of form should be quickened as much as possible by a heat-treatment that subjects the gage to more extremes of temperature than it will undergo while in use. This effect is obtained by the heat-treatment referred to.

After the gage has been rough-ground, enough metal has been removed to alter the internal strains and leave the structure of the metal in an unbalanced state. As previously mentioned in connection with carburizing and quenching, the hole in the gage blank closes in from 0.006 to 0.008 inch. If the outside diameter is carefully measured before and after carburizing, it will be seen that there is an increase of from 0.003 to 0.004 inch. The introduction of more carbon between the molecules of the steel would naturally tend to increase the distance between them and the size of the gage itself. The diagram Fig. 10 illustrates in a general way the form of the carburized portion of the case, which is represented by the vertical section lines, whereas the soft core is shown by the diagonal lines. When the gage blank is quenched, the threads cool first, so that the interior and the hole have a marked tendency to contract. As the outside surface and the faces of the gage are gradually reduced by the machining processes, these parts of the gage are gradually weakened, and the result is a slight contraction due to the interior strains. The gage remains comparatively cool throughout the grinding operations, so that the hardened surface does not become very elastic, and, therefore, is not affected directly by the forces acting upon it. For this reason, it is necessary to subject the gage to a high enough temperature to insure its taking a permanent set. A pack-hardened thread gage that has not been seasoned or subjected to some rapid seasoning process will change in diameter and lead so that it becomes practically useless. If such a gage is finished at the normal temperature and is allowed to remain near a furnace or other warm place, it will decrease in size and lengthen in lead. If a gage is heated to the equivalent of a light straw color and allowed to cool off, accurate measurement will show that it has reduced in size from 0.0002 to 0.0003 inch. Frequently in shops where gages are made, rejected gages are found which have changed considerably since the inspection previous to shipment, owing to the lack of proper seasoning. The effect of the lack of proper heat-treatment is illustrated by the following experience of

a gage-maker: All the operations on the gage, such as grinding and lapping, were finished without any special heat-treatment of the kind previously referred to, and the gage was made to the required size and passed inspection. This particular gage was kept as a master to be used in making duplicate gages. In less than two weeks, this gage had distorted to such an extent that it was from 0.0002 to 0.0004 inch out of round and the lead had shortened about 0.0002 inch.

Changes Due to Removal of Metal

The removal of metal will also cause appreciable changes of form or size which are often sufficient to spoil the gage entirely. For instance, a gage that had been finished to size was afterward altered by cutting away the threads at the ends back a distance of about one inch farther than they had been previously. This gage at the time was the right size and passed through a female master gage perfectly and without interference of any kind. In less than a week after cutting away the end threads, the gage had changed so much that it would not even enter the master gage one and one-half turn. The gage had a longer lead at each end and the outside diameter also decreased from 0.0002 to 0.00025 inch.

TABLE 1. AMOUNT TO BE ADDED TO OUTSIDE DIAMETER FOR MEASURING WHITWORTH THREADS WITH WIRES

Diam. of Wire	Threads per Inch							
	36	32	30	24	20	18	16	14
0.015	0.00302	.....	.....	.....	.....	.....	.....	.....
0.0175	0.01093	0.00538	0.00204	.....	.....	.....	.....	.....
0.020	0.01885	0.01329	0.00995	.....	.....	.....	.....	.....
0.0225	0.02676	0.02121	0.01787	0.00453	.....	.....	.....	.....
0.025	.....	0.02912	0.02578	0.01244	.....	.....	.....	.....
0.0275	.....	.....	.....	0.02036	0.00702	.....	.....	.....
0.030	.....	.....	.....	0.02827	0.01493	0.00604	.....	.....
0.0325	.....	.....	.....	0.03618	0.02285	0.01395	0.00284	.....
0.035	.....	.....	.....	.....	0.03076	0.02187	0.01075	.....
0.0375	.....	.....	.....	.....	0.03867	0.02978	0.01866	0.00437
0.040	.....	.....	.....	.....	0.03770	0.02658	0.01229	0.00229
0.0425	.....	.....	.....	.....	.....	0.04561	0.03449	0.02020
0.045	.....	.....	.....	.....	.....	.....	0.04241	0.02811
0.0475	.....	.....	.....	.....	.....	.....	0.05032	0.03603
0.050	.....	.....	.....	.....	.....	.....	.....	0.04394
0.055	.....	.....	.....	.....	.....	.....	.....	0.05977

Diam. of Wires	Threads per Inch							
	12	11	10	9	8	7	6	5
0.0425	0.00114	.....	.....	.....	.....	.....	.....	.....
0.045	0.00906	.....	.....	.....	.....	.....	.....	.....
0.0475	0.01697	0.00484	.....	.....	.....	.....	.....	.....
0.050	0.02489	0.01276	.....	.....	.....	.....	.....	.....
0.055	0.04071	0.02859	0.01403	.....	.....	.....	.....	.....
0.060	0.05654	0.04442	0.02986	0.01208	.....	.....	.....	.....
0.065	0.07237	0.06024	0.04569	0.02790	0.00567	.....	.....	.....
0.070	.....	0.07607	0.06152	0.04373	0.02150	.....	.....	.....
0.075	.....	.....	0.07735	0.05956	0.03793	0.00874	.....	.....
0.080	.....	.....	.....	0.07539	0.05316	0.02457	.....	.....
0.085	.....	.....	.....	0.09122	0.06899	0.04040	0.00229	.....
0.090	.....	.....	.....	.....	0.08481	0.05623	0.01811	.....
0.095	.....	.....	.....	.....	0.10064	0.07206	0.03394	.....
0.100	.....	.....	.....	.....	.....	0.08788	0.04977	.....
0.105	.....	.....	.....	.....	.....	0.10371	0.06560	0.01224
0.110	.....	.....	.....	.....	.....	.....	0.08143	0.02807
0.120	.....	.....	.....	.....	.....	.....	0.11308	0.05972
0.140	.....	.....	.....	.....	.....	.....	.....	0.12304

Multiples of 3.1657		
1 × 3.1657 = 3.1657	4 × 3.1657 = 12.6628	7 × 3.1657 = 22.1599
2 × 3.1657 = 6.3314	5 × 3.1657 = 15.8285	8 × 3.1657 = 25.3256
3 × 3.1657 = 9.4971	6 × 3.1657 = 18.9942	9 × 3.1657 = 28.4913

Finish-grinding Operations on Gage

After the last heat-treatment previously referred to, as much time as possible should be allowed to elapse before the finish-grinding operation, three or four days usually being sufficient. The finish-grinding is practically the same as the rough-grinding. The gage is wrung onto an arbor and the sides are finished to the required size.

The full diameter is also ground to size within 0.002 inch. After the sides of the gage are ground, the hole in some cases will be found to have closed in from 0.0001 to 0.0002 inch on the ends so that they should again be lapped to size. The sides of the thread are finish-ground on a machine of the type illustrated in Fig. 7, which represents the machine used for rough-grinding as well. It will be understood, of course, that the finishing operation requires more care than the rough-grinding.

One of the things that requires a little skill and experience is finishing the root of the thread. The actual root diameter is from 0.001 to 0.002 inch less than the nominal root diameter, so that at the beginning a wheel having a fairly sharp edge may be used. No attempt is made to dress the edge of the wheel to the radius of the root, since the root can be finished accurately enough for practical purposes by using a wheel which has an included angle of 55 degrees and a sharp edge or apex to begin with. As the grinding proceeds, this sharp edge naturally crumbles away and is finally rounded off sufficiently for finishing the root of the gage thread. After a wheel has removed, say, 0.001 inch, the effective diameter of the gage may be 0.003 inch over size, whereas the root diameter is perhaps only 0.001 inch over size. After another 0.001 inch has been removed, a measurement will usually show that the relation between the effective diameter and the root diameter has changed slightly. For instance, when the effective diameter is +0.002 inch, the root diameter may be +0.0005 inch, owing to the fact that the apex of the wheel has worn down slightly. One experienced in this work can reduce the gage by this method to the lapping size with one dressing of the grinding wheel and maintain the proper relationship required between the effective diameter and the root diameter. In the case of the particular gage selected as an example, when the effective diameter is +0.0003 to +0.0004 inch, the root diameter should be from 0.0012 to 0.0015 inch less than the nominal root diameter.

When beginning to grind a gage, it is well to consider the effect of expansion on the position of the wheel due to the heating of the wheel-spindle. Owing to the slight change due to this cause, it is advisable to keep the wheel running continuously when taking the finishing cuts. If it is necessary to stop the wheel for measuring or inspecting, when the wheel is again started it should be allowed to run idle long enough for the temperature of the spindle to rise to the normal working temperature before taking another cut.

Grinding Crest of Thread

After the angular sides of the thread gage are ground, the same machine is used for grinding the crest or top of the thread. By mounting the wheels as previously mentioned in connection with Fig. 6, it is possible to replace one wheel with another of different form with the maximum error not exceeding 0.0015 inch. Before grinding the crest of the thread, it is necessary to form a concave groove in the periphery of

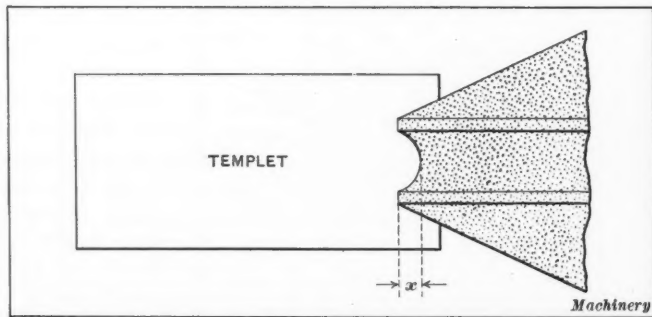


Fig. 12. Section of Wheel dressed for grinding Crest of Thread and Templet for testing Concave Groove in Wheel

The diamond-holder is next removed and is replaced by the fixture shown at B, Fig. 11. This fixture also has a V-shaped tongue for engaging the slots in the fixture shown in Fig. 8, and is provided with projecting arms on each side, containing holes through which a wire is inserted. This wire is used in finishing the concave groove in the grinding wheel to the required form. The cross-slide of the grinding machine is adjusted in far enough to come into contact with the wire which passes through the arms of the fixture and is held taut. The radius of this wire should correspond to the radius of the crest of the thread. In this particular case the crest radius equals 0.0098 inch, so that the wire should be 0.0196 inch in diameter or slightly larger. This wire should extend at least 12 inches beyond each guide bushing in the fixture and the ends are held lightly by hand when forming the groove in the wheel. As the wheel revolves, the wire is pulled tight enough to bring it into contact with the edge of the wheel, and then the wire is moved in first one direction and then the other a number of times. A piece of thin hardened steel is next held against the edge of the wheel, thus forming it to the shape illustrated in Fig. 12. The depth x of the concave groove is measured, and if it is not deep enough the wire is again used. On the contrary, if the groove is too deep, the top of the wheel may be dressed off with an ordinary diamond. When the groove has been properly formed, it is advisable to use the fixture shown in Fig. 8 for dressing the angular sides of the wheel, so that they will not come into contact with the gage thread when grinding the crest.

When starting to grind the crest the revolving wheel is adjusted inward until it comes into contact with the revolving gage. The position of the wheel in a direction parallel to the axis of the gage is determined by noting which side the sparks come from, and the wheel-spindle slide is adjusted accordingly by turning the knurled screw K, Fig. 7. As those who have had experience in grinding know, the sparks indicate inaccuracy of adjustment with greater precision and refinement than an indicator, and the wheel may be adjusted by this method until it is central with the thread within 0.00015 inch.

When grinding the crest of the thread a good micrometer should be available, and it is preferable to have one of the heavy type having an anvil and spindle 5/16 inch in diameter, because such a micrometer gives a better bearing surface on the top of the gage threads. When the top of the thread has been ground until the gage is within 0.001 inch of the

full diameter, it is advisable to test the radius of the crest by using a templet of the form shown in Fig. 12. This is usually a precautionary measure because if the instructions previously given have been followed there is not likely to be an error in the radius. After testing the radius with the templet, the grinding is continued until the full diameter is +0.0004 inch. This completes the grinding of the gage, and the next operation is that of lapping in order to remove all grinding wheel

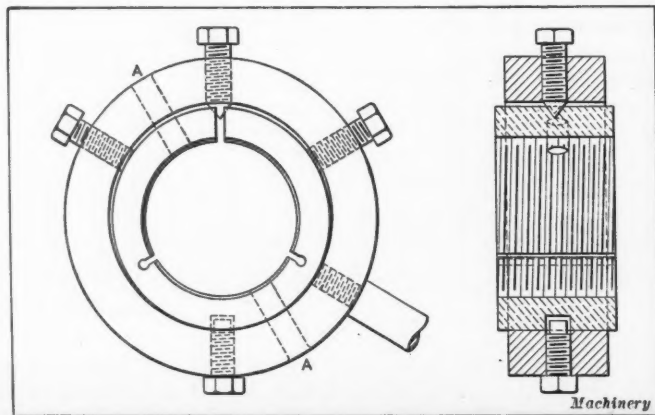


Fig. 13. Lap-holder and Lap for Use on Thread Gages

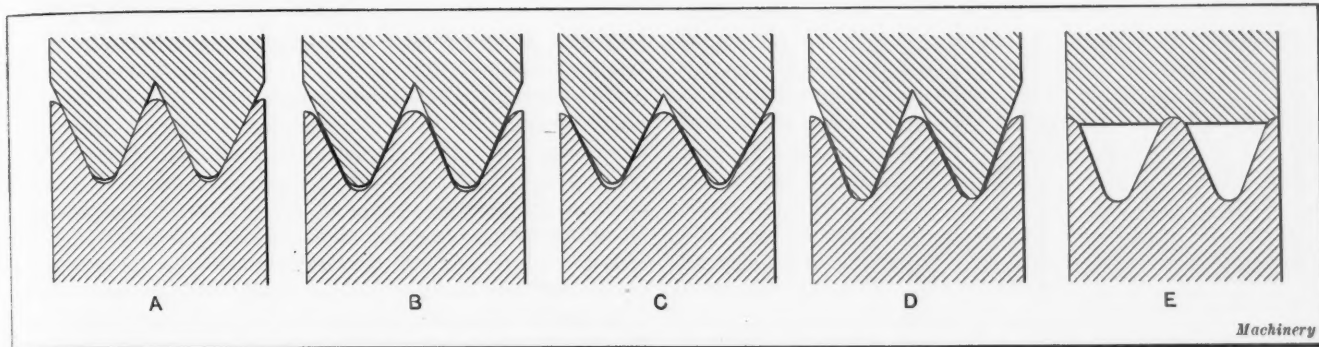


Fig. 14. Sectional Views showing Various Forms of Laps used on Thread Gages and Relation between their Form and a Standard Whitworth Thread

marks and reduce the gage to the final dimensions within the limits specified.

Laps for Thread Gages

While power-driven machines may be used for the lapping operation, lapping by hand will be described in the following, since it is regarded by the writers of this article as a better and more rapid method. When there is an unusual amount to be lapped off, the machine will remove the metal somewhat faster, but it is important to remember that the time required for actually lapping is small as compared with the time required for cleaning the work, taking measurements, etc., which can be done faster when lapping by hand.

Gray cast iron that is free-cutting and without blowholes has proved to be the best material for the laps used on thread gages. This material charges well and is less subject to changes than some other materials that are used. Cold-rolled steel and machine steel have been employed, but are not entirely satisfactory. These materials at times seem to retain the form of the thread fairly well, but there is often difficulty due to distortion. In order to obtain the best results, the lap should extend beyond the ends of the thread on the gage at least one-half inch. Occasionally, however, a short lap is required, as, for example, when a gage is slightly tapering or large either in the center or at the ends. For making corrections of this kind, laps having only three or four threads are used because one covering the entire gage could not, of course, be used to correct local errors.

A convenient form of lap-holder is shown in Fig. 13. This consists of a ring or shell containing three adjusting screws and a handle. A lap of the kind used for lapping the angular sides of the thread is shown in position in the holder. There should be five laps and holders for the use of each man working on thread gages. These five laps differ in form as illustrated by the detailed sectional views, Fig. 14. The "perfect" lap illustrated at A is made to the standard angle of 55 degrees and it bears on the sides only, there being clearance spaces for the root and crest of the gage thread. The lap illustrated at B has a slightly more acute angle than the lap shown at A. This is known as the "acute" or "bottom" lap and it may have an inclination of, say, 54 degrees. The obtuse lap illustrated at C has an angle of 55½ degrees, so that it bears on the upper part of the gage thread. The root lap D is made to bear on the root only, as the illustration shows, and at E is shown the lap used for finishing the crest or top of the gage thread. These different laps should be plainly marked so that the wrong one will not be used.

Lapping Operations on Whitworth Thread Gage

The thread gage to be lapped is placed in a holder which is securely held in a vise, and before any lapping is done it is carefully measured. The form of lap illustrated at A, Fig. 14, is first used. This lap is slightly charged with an abrasive mixed with vaseline to form a paste, this mixture being in-

troduced through the holes A shown in Fig. 13, extending through the holder and lap. The screws of the holder should be adjusted so that the lap has a slight drag, as it is screwed over the gage. The lap, when in use, is turned forward and backward for several minutes, care being taken to see that it is always working over the entire gage surface. After removing the lap and thoroughly cleaning the gage with gasoline, the lead of the gage thread is checked by using the form of gage shown in Fig. 15. This gage consists of two circular disks ground accurately to the standard thread angle of 55 degrees and spaced a distance apart equal to some multiple of the thread gage pitch. This gage is used by simply placing the disks into mesh with the thread gage and noting whether or not it fits perfectly as determined by a "light test" or by sight.

It is also essential to test the angle of the thread, which may be done by using wires and a micrometer, the same as when measuring the effective diameter. When beginning to lap, the angle is supposed to be correct and the effective diameter of the gage about 0.0004 inch over size and the root diameter 0.0012 inch less than the nominal root diameter. Two sets of wires varying in diameter are used for testing the angle. Suppose in this case that a measurement over the large wires of 0.055 inch diameter shows that the gage is + 0.0002 inch and that the measurement is + 0.0003 inch when using the small wires having a diameter of 0.0375 inch. This shows that the angle of the gage thread is slightly obtuse or over 55 degrees. In order to correct this error, the lap shown at B, Fig. 14, is used. When this lap is removed, measurements may show that the gage is + 0.00015 inch over the large wires and + 0.0001 inch over the small wires, thus showing that the error in angle has been partly corrected.

Before finishing the lapping of the sides of the thread, the form of lap shown at D, Fig. 14, is used for reducing the root of the thread to the required size, which in this case is about 0.0015 inch less than the nominal root diameter. The lap A which was first used is again placed on the gage and is charged with rouge. After the lap has been given a number of turns in each direction, it is removed for testing the size of the gage, and this is repeated until the gage has been reduced to the required size. The first abrasive used, which is coarse as compared with the rouge, tends to creep up the sides of the gage thread and remove more material at the top, which accounts for the fact that the gage thread angle is sometimes a trifle wider than it should be. When rouge is used, the lap has more of a rubbing than a cutting

effect and the abrading action on the side of the gage thread is more even than when using a coarser abrasive. In some cases, the gage thread is ground to an angle which is slightly less than required, in which case the obtuse form of lap shown at C is employed.

The time required for lapping one of these gages should not exceed two and one-half hours, and where a number of duplicate gages are being made, it is possible under favorable conditions for one

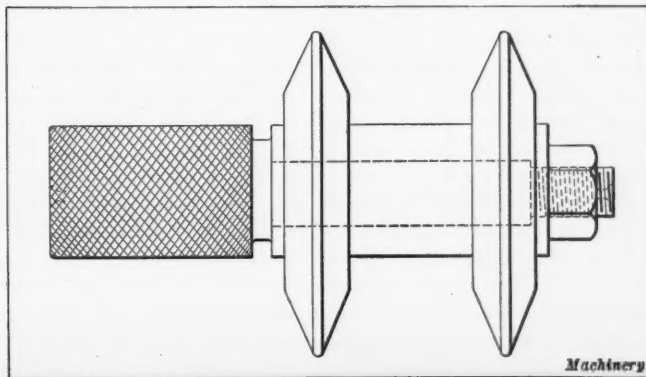


Fig. 15. Simple Form of Gage used for testing Lead of Gage Thread

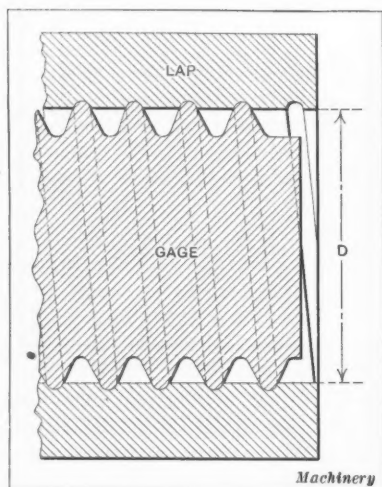


Fig. 16. Diagram illustrating Type of Lap used for lapping Crest of Gage Thread

man to lap twelve gages a day. As previously mentioned, the laps for use on the sides of the thread are made so that they will clear the crest and root. As a lap wears down, however, the clearance space decreases and it may be necessary to remove a little metal from the top of the lap thread. The lap may be tested for clearance by first placing it on a thread gage and adjusting the screws until it turns with a slight drag; the lap is then removed and a plug gage 0.001 inch smaller than the nominal core diameter is tried into the gage. If this plug passes through, the lap still has sufficient clearance, but if the gage cannot be inserted, a reamer 0.001 inch larger than the core diameter should be run through the lap.

It is not only necessary to have the gage thread of the correct angle, but the angle between each side and the axis of the gage should also be the same. A gage thread that is tilted with relation to the axis may be due to the use of a lap cut with a tool that was not set properly. The angle of the tool may be correct, but, of course, it is essential to set it so that each cutting edge has the same inclination relative to the axis of the lap. It is good practice when using a lap to reverse its position relative to the thread gage. When this is done, if the lap thread is tilted this will soon be apparent, owing to the obtuse angle given to the thread gage.

Sometimes the sides or slope of a gage thread are lapped concave instead of extending in a straight line from the crest to the root. This is usually due to the use of a lap that is too acute. Sometimes the opposite effect is produced and the sides of the thread are lapped convex instead of concave. This may be due to the use of a lap that is not properly adjusted and one that works too freely or wabbles. If the obtuse lap *C*, Fig. 14, is used too long it will, of course, increase the angle of the gage thread beyond the standard of 55 degrees, and if the root lap *D* is used too long the thread will be too deep and the angle too small.

Lapping Crest of Thread

The form of lap used for finishing the crest is shown by the sectional view, Fig. 16. This lap has a helical concave groove corresponding to the pitch of the gage thread and of the same radius, in cross-section, as the crest of the thread to be lapped. This lap is bored out to a diameter *D* equal to the full diameter of the gage thread, minus twice the vertical distance *x* (see Fig. 3) from the top of the thread to the point where the crest is tangent to the side of the thread.

The depth of the concave groove in the lap for different pitches is given in Table 2 and also the radius of the thread crests.

When using the crest lap it should be adjusted so that it bears very lightly on the thread being lapped. Many gages have been spoiled by adjusting the lap too tightly. When lapping the angular sides of the thread, there is at least six times as much surface being lapped as when lapping the crest. Notwithstanding this fact, many mechanics apply the same amount of pressure, and the result is that the lap itself is cut instead of the work. The lap should be adjusted for this operation so that one is just able to feel the drag or pull. If used in this way, the lap will cut properly and retain its shape while lapping a number of gages. This lap should also be reversed frequently the same as when using the angle laps. If the lap for the top radius or crest is not properly made, this section of the thread may be finished slightly off center. It is important to remember that the full diameter is reduced quite rapidly when lapping the crest. The radius should be tested occasionally by using a templet gage similar to the form illustrated at *F* in Fig. 9.

TABLE 2. RADII OF CREST AND ROOT AND VERTICAL DISTANCE *x* (SEE FIG. 3) TO POINT OF TANGENCY

Threads per Inch	Radius of Root and Crest	Vertical Depth <i>x</i> of Crest	Threads per Inch	Radius of Root and Crest	Vertical Depth <i>x</i> of Crest
36	0.00382	0.00206	13	0.01056	0.00568
32	0.00429	0.00231	12	0.01144	0.00616
30	0.00458	0.00247	11	0.01248	0.00672
24	0.00572	0.00308	10	0.01373	0.00740
20	0.00687	0.00370	9	0.01526	0.00821
18	0.00763	0.00412	8	0.01717	0.00924
16	0.00858	0.00462	7	0.01962	0.01056
14	0.00981	0.00528	6	0.02289	0.01232

The abrasives that have proved satisfactory for lapping thread gages are carborundum, alundum, emery, and rouge. Carborundum gives excellent results in rough-lapping, especially when there is considerable material to be removed and the lap does not have to retain an accurate form. Alundum (65F) if used for finish-lapping ground gages will produce a finish that is nearly as fine as that obtained with rouge, and the thread may be lapped to size much quicker. Emery, being tough and sharp, will cut for quite a long time without recharging and is preferred by some gage-makers. Rouge is used when a high polish is desired. Satisfactory results may be obtained by using flour emery (grades F to F4) for lapping gages after grinding and then using rouge for removing, say, 0.00005 inch. Lard oil has proved to be a good lubricant to mix with abrasives for lapping thread gages.

Timing Lapping Periods

When lapping a thread gage or any other tool or part which must be reduced by the lapping process to a given dimension within small limits, the work can be done with less chance of error and more quickly by timing the lapping period, provided the relation between the lapping time and the reduction

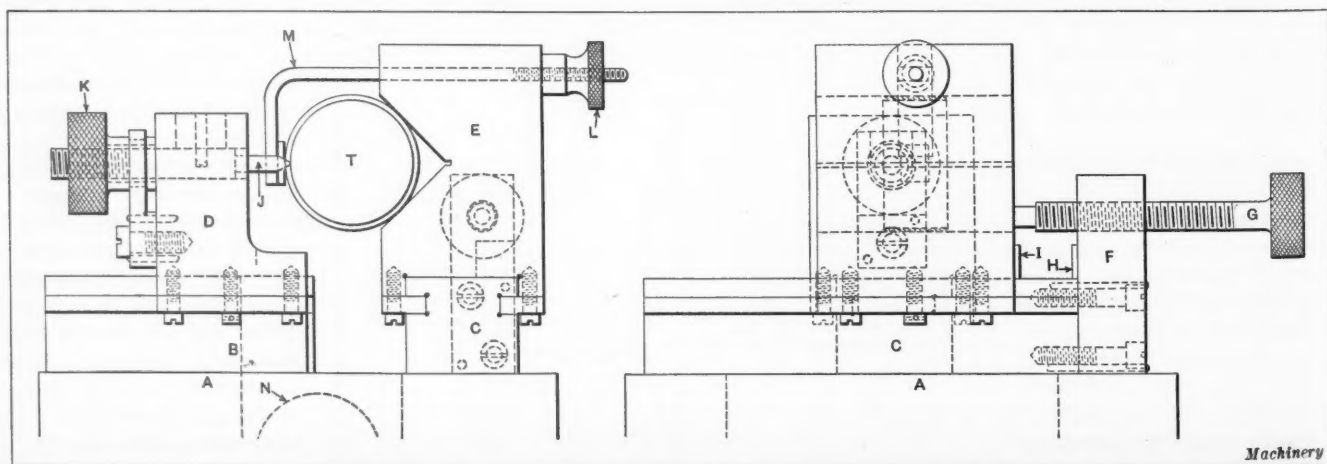


Fig. 17. Gaging Fixture for testing Lead and Angularity of Gage Thread

in size during that time has been determined previously. It is generally recognized, of course, that if a cutting tool removes a given amount of material in a given time, the same tool or one similar to it operating under corresponding conditions will approximately duplicate the amount of work done during equal periods of time. It also holds true that if a lap removes a certain amount of metal in a given time the same lap or another one like it used under similar conditions will repeat the performance. For instance, if a lap freshly charged with a certain abrasive is used continuously for, say, ten minutes, and careful measurements show a reduction of 0.0004 inch in size, it is reasonable to assume that this relation between the lapping period and the amount of metal removed may be used as a basis for determining the time required for making further reductions in size. To illustrate, suppose in this case that a lapping period of ten minutes reduced the size of the lap 0.0004 inch and that a measurement showed that there was 0.0002 inch more to be removed; in that case, the next lapping period might be five minutes in order to remove the 0.0002 inch, although it would be advisable to reduce this time somewhat in order to be on the safe side. Thus, instead of lapping continuously for five minutes, the lapping period might be reduced to four minutes, after which the part would again be measured. This simple principle as applied to lapping, eliminates largely the uncertainty connected with the lapping process, and makes it possible to reduce a precision tool, such as a thread gage, to the required size without taking so many measurements in order to avoid spoiling the work. In fact, by carefully timing the lapping periods, it is possible to reduce a thread gage to a specified dimension in three or four lapping periods. This method of procedure has in part made it possible for one toolmaker to produce from ten to twelve gages a day, when the gages have been properly ground to begin with.

Hardness Test for Thread Gages

The thread gages are tested for hardness at the root of the thread by using a high-grade knife-edge file instead of a scleroscope or Brinell hardness tester. If the gage is not as hard as it should be, the softness may readily be detected at the root of the thread because there is less carbon penetration at the root than at other sections of the thread, as indicated by the diagram, Fig. 9; consequently, if the root is sufficiently hard, it is safe to assume that the other parts of the thread are satisfactory in this respect. Each gage is tested in a number of places on the root of the thread, and if the file takes hold or cuts the gage, the latter is considered too soft and is rejected.

Lead and Angle Checking Gage

The gaging fixture shown in Fig. 17 has proved very satisfactory for testing the lead of the thread gage and also the angle of the thread, as well as its position relative to the axis. Mounted upon the base *A* of this gage there are two blocks *B* and *C* which are hardened, ground, and lapped. Block *C* carries another block *E* which can be adjusted by screw *G* and has a 90-degree notch on the side for receiving the gage *T* to be tested. In the opposite block *D* there is a spindle *J* which can be adjusted in or out by the knurled nut *K*. Spindle *J* is finished very accurately on the point to conform to the standard thread angle of 55 degrees. The arm or finger *M* which is adjusted by nut *L* is used to hold the gage in position. The gage to be tested is held in the groove of block *E* and is then adjusted until spindle *J* is in exact alignment with a thread groove near the end of the gage, by adjusting screw *G* and nut *K*, as may be required. The relation between the end of spindle *J* and the gage thread is then noted. The electric light bulb *N*, which is opposite an opening in the gaging fixture, makes it possible to see any slight difference between the contact of spindle *J* and the gage. If the contact is satisfactory, the distance between the finished surfaces *H* and *I* is then measured accurately by means of size blocks. Spindle *J* is next withdrawn far enough to clear arm *M*, and block *E* is adjusted to locate spindle *J* in line with a thread groove near the opposite end of the gage. After spindle *J* is placed in contact with the gage thread as before,

the bearing between the spindle and the gage thread is again noted. If the end of the spindle and the gage thread coincide, the distance between the finished surfaces *H* and *I* is again measured and the difference between the two measurements thus taken is used in checking the lead of the gage thread. This may readily be done by simply noting the number of threads on the gage between the two places where spindle *J* was brought into contact with the gage thread. This number is then multiplied by the required pitch, thus giving a result which should correspond to the distance that surface *I* moved from surface *H* in changing spindle *J* from the first to the second position.

* * *

INCREASING WAR PRODUCTION AND SAFEGUARDING WORKERS

In view of the urgent necessity for a prompt increase in the volume of production of practically every article required for the conduct of the war, vigilance is demanded of all those in any way associated with industry, lest the safeguards with which the people of this country have sought to protect labor should be unwisely and unnecessarily broken down. It is a fair assumption that for the most part these safeguards are the mechanisms of efficiency. Industrial history proves that reasonable hours, fair working conditions, and a proper wage scale are essential to high production. During the war every attempt should be made to conserve in every possible way all our achievements in the way of social betterment.

The day's work should not exceed the customary hours in the particular establishment or the standard already attained in the industry and in the community. It should certainly not be longer than ten hours for an adult workman, and should not exceed eight hours for women and minors. No woman should be required to lift repeatedly more than twenty-five pounds in any single load. The theory under which "time and a half" is paid for overtime is a tacit recognition that it is usually unnecessary and always undesirable to have overtime. Eight hours per shift should be a maximum in continuous twenty-four-hour work, and the employment of women on night shifts should be prevented. The half holiday on Saturday is already a common custom in summer, and it is advantageous throughout the year, especially if the workday is ten hours long the remainder of the week. The working period on Saturday should not exceed five hours. An occasional shift of two or three hours on Saturday afternoons is unobjectionable if essential, but the additional hours should be regarded as overtime and paid for on that basis. One day of rest in seven should be a universal rule. The observance of national and local holidays will give opportunity for rest and relaxation which tend to make production more satisfactory.

Existing legal standards to prevent danger from fire, accident, occupational diseases, or other hazards, and to provide good light, adequate ventilation, sufficient heat, and proper sanitation should be observed as minimum requirements. Processes in which workers are exposed to excessive heat (that is, over 80 degrees), or excessive cold (that is, under 50 degrees) should be carefully supervised so as to render the temperature conditions as nearly normal as possible. When extreme temperatures are essential, workers should not only be properly clothed but should avoid sudden changes.

The need of preserving and creating methods of joint negotiations between employers and groups of employees is especially great in the light of the critical points of controversy that may arise in a time like the present. Existing channels should be preserved and new ones opened, if required, to provide easier access for discussion between an employer and his employees over controversial points. When it is necessary to employ women in work hitherto done by men, care should be taken to make sure that the task is adapted to the strength of women. The standard of wages hitherto prevailing for men in the process should not be lowered where women render equivalent service. The hours for women engaged in such processes, of course, should not be longer than those formerly worked by men. No work shall be given out to be done in rooms used for living purposes or in rooms directly connected with living rooms in any dwelling or tenement.

PRECISION SCREW MEASURING MACHINE

APPARATUS FOR MEASURING PITCH, PITCH DIAMETER, EXTERNAL DIAMETER AND ANGLE OF SCREW THREAD

THE precision screw measuring machine to be described is of the general type which is provided with a microscope for accurately setting the screw thread to be measured in different positions and micrometer screws for determining whether or not the dimensions of the screw thread conform to required standards. A general view of this machine is shown in Fig. 1 and a side elevation in Fig. 2. The fixed microscope A, Fig. 2, through which the screw thread is viewed, is mounted so that it can be adjusted in a lengthwise direction for focusing and provision is also made for turning the microscope about its axis for making tests that will be referred to later. When a screw thread is to be inspected, the microscope is inclined either to the right or to the left (depending upon whether the thread is right- or left-hand) so that the axis of the microscope is in line with the screw thread instead of being perpendicular to its axis. The position of the microscope relative to the screw thread is indicated in Fig. 3. The object of this adjustment is to enable a correct view of the profile of the thread to be obtained. The angle α equals the helix angle of the thread, and the position of the microscope is indicated by an arc graduated to half degrees.

The screw to be tested is held in a self-centering split chuck. A set of these chucks is provided to take all sizes of screws within the regular capacity of the instrument. The chuck in use is held at one end of a cylindrical spindle that is supported in vees. These vees are adjustable so that the axis of the spindle may be set true. By sliding the spindle in the vees any desired part of a screw thread may be inspected, and by turning the spindle about its axis, it is possible to locate under the microscope as many different sections or profiles of the screw as may be considered desirable. This chuck spindle is turned or traversed by means of a milled screw located on the opposite side of the instrument from that shown in Fig. 1. The outer face of this milled screw head is divided into 72 divisions of 5 degrees each to indicate the angles through which the spindle is turned. Readings are taken with reference to a pointer which is delicately pivoted and has most of its weight below the point of support; consequently, this pointer is maintained by gravity in the upright position with as much accuracy as is necessary for the adjustments

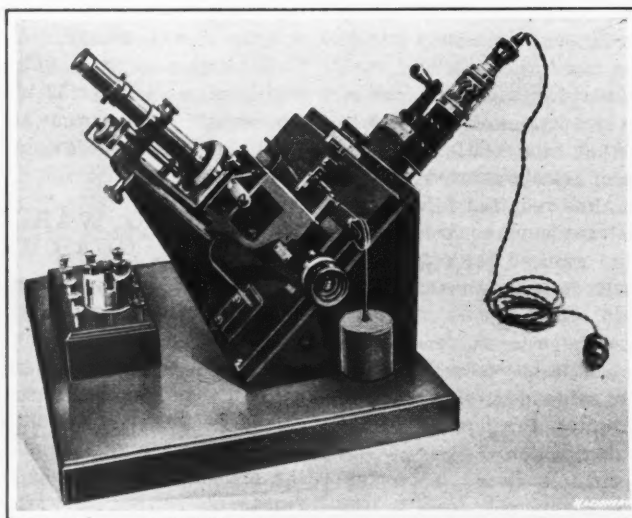


Fig. 1. Precision Screw Measuring Machine made by Cambridge Scientific Instrument Co., Ltd.

of the spindle. In addition to the movements which have just been referred to that enable the screw thread under test to be set in a position suitable for observation, there are two fine adjustments controlled by micrometer screws. One of these adjustments enables the screw being tested to be moved in a direction perpendicular to its axis. The micrometer screw at B, Fig. 2, serves to control this adjustment. In conjunction with this micrometer there is a short scale (see Fig. 1) for registering complete turns of the micrometer screw. The range of movement provided for is 15 millimeters (0.5906 inch). The micrometer screw is of $\frac{1}{2}$ millimeter pitch (0.0197 inch) and the screw head is divided into 50 parts, enabling readings to be taken directly to 0.01 millimeter (0.0004 inch). The screw under test may also be traversed in the direction of its axis by means of another micrometer screw which is similar to the one just referred to and is clearly shown in Fig. 1 attached to the right-hand side of the instrument.

Before taking any measurements, the microscope must be focused properly so that the profile of the thread under observation is clearly defined. This is done by first focusing on that part of the screw thread which is nearest to the microscope. The microscope will then be in some position A, Fig. 3, with its axis in the same plane as the axis of the screw to be tested. When the microscope is in correct focus for this position, it is then adjusted to some position B so as to be in focus with the profile of the thread in a plane x-x. In order to do this, the microscope is moved downward in a direction perpendicular to the axis of the screw, a distance y equal to the radius of the screw. Since the microscope is inclined an amount α equal to the helix angle of the screw thread, the actual adjustment y of the microscope in an axial direction is equal to the radius of the screw multiplied by the secant of angle α . The microscope is first focused on the

uppermost part of the thread, as previously mentioned, and is then adjusted by measurement to bring it into focus with the profile because it is easy to focus it upon the upper part of the thread by noting the clearness and sharpness of the thread as the microscope is adjusted axially in one direction or the other. If an attempt were made, however, to focus the microscope in this manner upon the profile in a plane x-x, it would be difficult to determine when that particular part of the profile is in

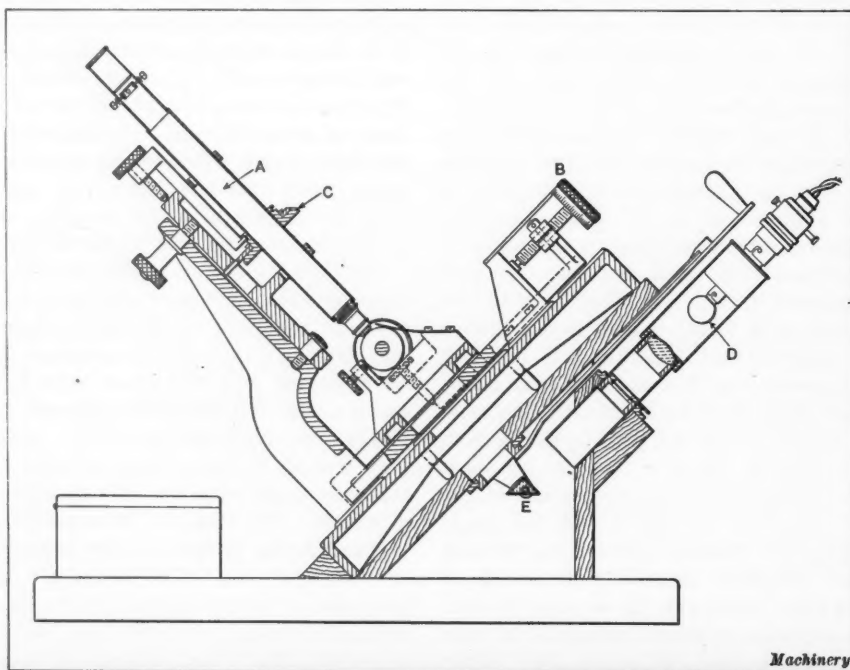


Fig. 2. Side Elevation of Screw Measuring Machine shown in Fig. 1

the proper focus, owing to the tangential position of the microscope.

The microscope is provided with two fine lines extending at right angles across the field as illustrated at A, Fig. 4. These lines are used in making accurate adjustments in connection with the tests described in the following: The two settings required for determining the external diameter of the screw thread are indicated at B and C, which show the relative positions of the screw thread and the cross-lines in the field of the microscope. When measuring the diameter, the screw is first adjusted in a direction perpendicular to its axis by means of the micrometer screw B, Fig. 2, until the points or tops of the threads exactly coincide with one of the cross-lines as illustrated at B, Fig. 4. The reading of the micrometer is then noted, after which the screw is adjusted until the points of the threads on the opposite side coincide with the cross-line as indicated at C. The difference between the micrometer readings for the two positions represents the external diameter of the screw.

The method of setting the screw preparatory to testing the pitch of the thread is illustrated at D. The intersection of the two cross-lines coincides with the slope or side of the thread. After the screw is accurately set in this position, it is traversed axially until the cross-lines again intersect the slope of the adjacent turn of the thread. The pitch, of course, is equal to the difference between the micrometer readings for the two positions. This test for pitch may be applied to different parts of the length or circumference of the screw thread, owing to the adjustments provided, so that any lack of uniformity in the pitch can be detected and measured. The cross-lines of the microscope may also be set as indicated at E for testing the pitch.

For measuring the angle of the thread one of the cross-lines is set to coincide with the slope of the thread as indicated at E, by turning the microscope about its own axis. The inclination of the cross-line to the mean position may be read directly on the graduated disk C, Fig. 2, which is located near the objective end of the microscope (see also Fig. 1). In order to determine the effective or pitch diameter of a screw thread, the intersection of the cross-lines is set to coincide with the thread, the same as indicated at D, Fig. 4, for testing the pitch. The screw is then adjusted laterally until the cross-lines intersect the slope of the thread on the opposite side, and the difference between the readings for the two positions represents the effective diameter.

While the adjustments of the screw in a lateral and an axial direction are similar to those obtained with the well-known compound slide-rest, the carriage of this instrument differs from such a slide-rest in that the upper and lower members are supported directly upon the same bed-plate, instead of the upper member being mounted on the lower one. This cast-iron bed-plate has six bearing surfaces. Three are for sup-

porting the lower plate of the carriage and three for the upper plate. The design of the slides is strictly "geometrical" and all play or backlash is eliminated by applying such loads to the slides that the thrust against the micrometer screws is always in one direction. The weight seen at the right-hand side of the instrument in Fig. 1 is utilized for this purpose.

This instrument is equipped with an illuminating apparatus so that the profile of the screw thread under observation will be clearly defined. For ordinary work an electric lamp may be used, but to insure accuracy when measuring screws of different an-

gles, it is necessary to use a parallel beam of light and to provide means for varying the angle of incidence of the light. For this reason, the special illuminating apparatus shown applied to the instrument in Figs. 1 and 2 is recommended. A Nernst lamp D, Fig. 2, in conjunction with a prism E illuminates the screw from below and throws a parallel beam of light up the microscope tube parallel to the optical axis. This illuminating apparatus can be adjusted to the right or left in accordance with the angle at which the microscope is inclined. This instrument was designed and constructed by the Cambridge Scientific Instrument Co., Ltd., of Cambridge, England. It was made for the small screw-gage committee of the British Association for testing the accuracy of commercially produced screw threads and taps.

* * *

TRANSPORTATION OF ARMY TRUCKS AND TRUCK PARTS

In an effort to relieve the congestion at freight terminals and at the same time test the trucks that are being built for it, the Quartermaster's Department is transporting all new army trucks under their own power, from the factories in which they are built to Baltimore, where a large repair shop has been established. It is expected that the shipment of 30,000 war trucks to the coast by this method will relieve 15,000 freight cars and also permit the transportation of 90,000 tons of other government materials to the coast from the interior storage depots. These trucks will move in trains of thirty each and will be in charge of eighty men. Twenty-nine of the first train, carrying sixty tons of spare parts, made the trip from Detroit to Baltimore in fourteen days, on three and a half of which they did not travel. They thus averaged fifty-five miles a day, though the temperature reached eight degrees below zero and large snow-drifts were encountered. This train consisted of three-ton Packards and included tank trucks, with gasoline and oil, and a kitchen truck. One of the trucks was wrecked by a railroad train just after the truck train left Detroit. Some of the trucks will undoubtedly be shipped to France from Baltimore; others will be merely assembled there for shipment from other Atlantic ports.

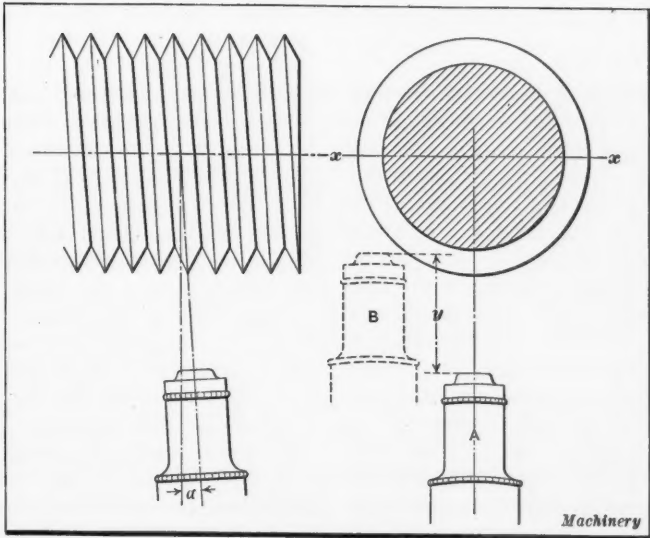


Fig. 3. Angular Position of Microscope Relative to Screw Thread and Method of focusing it

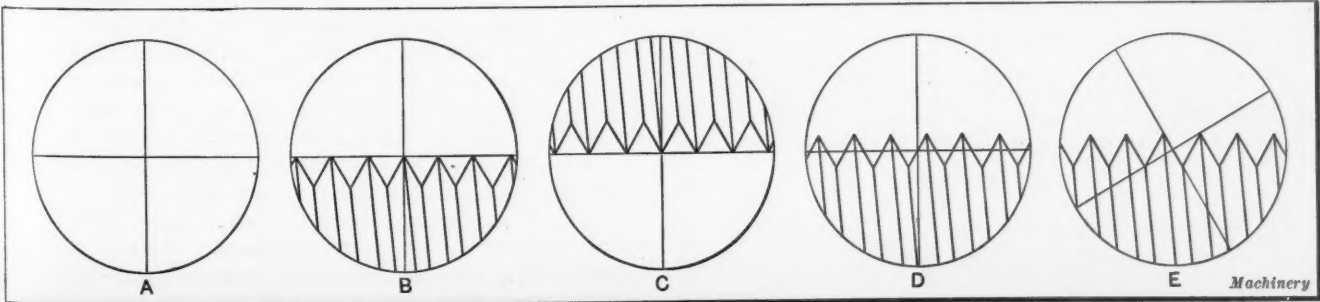


Fig. 4. Cross-lines in Field of Microscope and their Position Relative to Screw Thread for Different Measurements

PLANING COLD-DRAWN STEEL PARTS

BY DONALD A. HAMPSON¹

Every shop man knows the tendency of cold-drawn steel to spring after a cut has been taken over the surface. If his experience has been confined to lathe work, however, he does not realize to what an extent this is the case, for in turning the bar is invariably accurately centered and the same amount is removed from all sides, so that the strains are nearly equalized and the spring is usually negligible. But on the milling machine or planer, where a cut is taken off one side, the tendency is most evident, often to the dismay of the machinist, who expected a better job. The amount of spring, or bow, in a piece that has been planed depends on the amount of stock taken off, the grade of steel, the anneal or lack of it, the length of the piece, the setting up, and whether or not the bar was straightened before being set up. If a straight bar of steel three feet long has $\frac{1}{8}$ inch taken off one side, when released it will spring in the middle nearly $\frac{3}{8}$ inch. The bow is always upward in the middle of the cut side. Before that piece can be used, it must be carefully straightened; and if the requirements are close and the bar must hold a piece of cigarette paper at any point, the skill required is of the highest order. Then, if a cut is taken from the other side, the straightening must be done all over again. It is possible to combat this springing on much work or to meet it fully half way, as is shown in the following examples:

The I-shaped piece shown at A, Fig. 1, is planed from the solid, no other construction being permitted. The maximum limit is 0.001 inch each way and from one to six pieces are required at a time; the lengths of the pieces may vary. When only one piece was ordered, the entire job took six hours, including the straightening and the setting up, though bars less than three feet long were often completed more quickly. In any case, it was work that no one liked to do, because it showed so little results for the time it demanded; besides, the bars were sold at a fixed price per inch and there was no money in them. Short lengths were planed in a vise, but most of the bars were long and were held directly on the planer table against a rib, using the regular planer equipment of posts, fingers and blocks. It was decided to make a long rib just adapted to the work, and fixtures that would be self-contained and require no fingers; the outfit was to be made so as to accommodate from one to four bars at a time. This outfit effected a saving of fifty per cent on orders for single bars, and more when the orders were larger. The saving was possible because there were fewer parts to handle and because the straightening was reduced to a minimum.

The first operation, notching the ends B to get tool clearance and square corners, was done in the milling machine as before. The bar C was then fastened against the long rib D by screws in the blocks E. There are two screws in each block and enough blocks are used on a job for a screw to bear against the bar every seven inches of its length. Slots in the under faces of the castings allow the tongues to be shifted to give a working space that will accommodate the number of bars planed and to bring the contact end of each screw at the right height. A strip H prevents the screws from marring the work.

Before setting up the work, the bar of drawn steel is inspected and straightened to within 0.005 or 0.006 inch, if necessary. Then one side is planed down to the milling cut, finishing it in two or three cuts. This side is then completed, but

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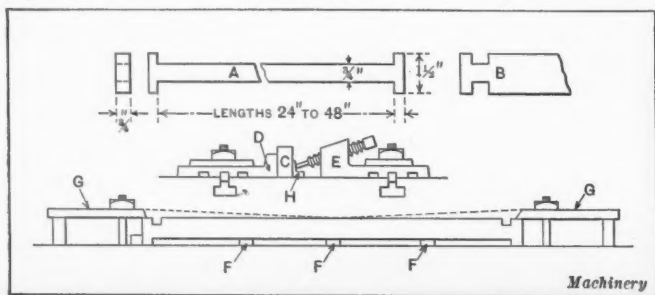


Fig. 1. Methods of planing Cold-drawn Steel Parts

is badly bowed. Instead of straightening it, the bar is laid on blocks F $\frac{3}{8}$ inch thick, and a clamp G is put on each end, drawing these down until all the blocks are tight. The shape of the bar before clamping is shown by the dotted line. After clamping, the second side is planed as was the first; but when released the bar is perfectly straight—commercially—so that not more than one piece out of thirty has to be touched up. The amount removed from each side being the same, the strains in the bar that are released by the cuts just balance, and the finished piece comes out better than the blank.

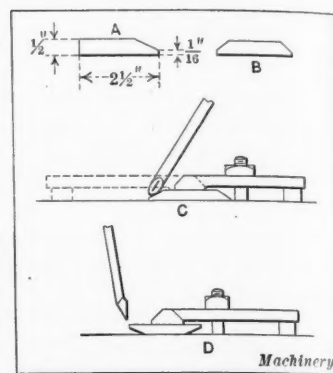


Fig. 2. Printers' Straightedges made from Cold-drawn Steel

In the printing business there is some demand for long straightedges of the form shown at A, Fig. 2; but as printers object to paying the price for the hardened and ground machine shop variety, they are made of cold-drawn steel. They are supposed to hold a piece of newspaper when laid flat side down or when stood on either edge on a press bed, and are from forty to seventy inches long. A cut over any one face will create a bend in the steel that can be straightened with time and patience, but the bevel cut sets up a double bend that makes it exceedingly difficult to straighten the piece within 0.01 inch. It was customary to take a light cut from both edges, releasing and resetting for each cut, but after each cut the strip would spring again. However, it was found that the users preferred straightedge B with two beveled edges instead of one, if they could get it for the same price. So after the piece is cut from the bar, it is inspected to see that the broad side is flat and true. Then it is clamped down as shown at C and one bevel cut. Before the clamps are taken off, a second set of clamps, shown by the dotted lines, is put on, to hold the piece from springing, and the second bevel is cut. There is then only one bend visible, and that one is easy to remove. To insure the narrow edges being straight, the piece is turned over, as shown at D, and the same clamping system employed for these cuts. Freedom from wind and a true edge are the pleasing results.

* * *

CUTTING-OFF OPERATIONS

Cutting off is a fundamental operation of manufacturing, and the importance of cutting-off machines in all kinds of manufacturing often is not fully realized. Practically every manufacturing process requires that material be cut to length and width before or after other operations are performed. In the machine shop we have hacksaws, power saws, bandsaws, cutting-off lathes, pipe machines and other tools that are used as much for cutting off as for actual shaping. Even the planer is sometimes used for cutting stock into strips, removing risers, and other cutting-off operations. It is very common to use a shaper for this purpose, and every machinist has had the job of cutting off bar stock in the lathe. The milling machine with a gang cutter makes an excellent cutting-off machine, especially for strip work. The boiler shop has power shears, circle shears and other machines for cutting boiler plates into the shapes required.

If cutting-off operations are important, then the machines used for those operations are important. The hand hacksaw and the power hacksaw are useful if not absolutely indispensable tools in metal-working shops. Often lathes costing several hundred dollars are used for cutting bars to length because cheaper and simpler cutting-off machines are not provided. The power hacksaw is commonly looked upon as a cheap and inconsequential machine, but it is one of the most important in the machine shop and deserves higher regard than is commonly bestowed on it. Power hacksaws should be first-class machine tools and sold at prices commensurate with their quality. The shop manager should aim to provide these humbler essential tools that supplement the more costly ones.

RECENT DEVELOPMENTS IN BALANCING APPARATUS¹

IMPORTANCE OF OBTAINING PERFECT STATIC BALANCE BEFORE ATTEMPTING TO SECURE DYNAMIC BALANCE—
NEW FORM OF DYNAMIC BALANCING MACHINE

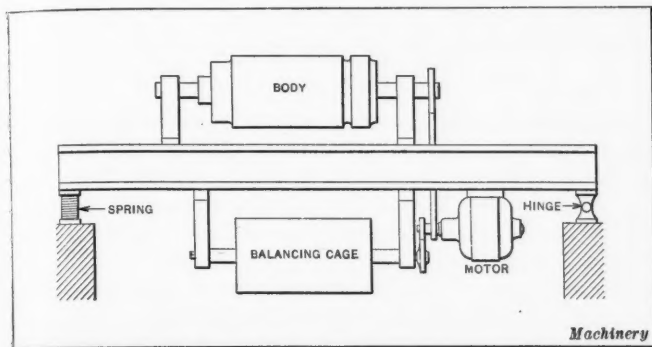


Fig. 1. Squirrel-cage Type of Dynamic Balancing Machine

A BALANCING machine developed by the writer some time ago, shown in Fig. 1, consists of a lathe bed, in the form of a beam, hinged at one end and supported by a spring at the other. The body to be tested is brought into static balance and then rotated in bearings supported by the bed. If the body is dynamically unbalanced, its rotation will cause the bed to vibrate in a vertical plane with a period of oscillation equal to the period of rotation of the body.

Suspended from the bed is a so-called squirrel cage, which consists of two circular disks that carry an even number of rods arranged to slide in holes in the disks. The cage rotates in unison with the body to be tested, so a state of unbalance in this body introduces a centrifugal couple that is neutralized by displacing the rods in the cage until an equal compensating couple has been introduced. The distances that the rods are displaced measure the amount of unbalance to be provided for and counterbalanced in the piece under test.

The improvements upon this machine are as follows: (1) The substitution for the cage of a two-point element, consisting of two disks, each with a pin projecting from its face, as shown in Fig. 2. The disk A is fixed to its shaft and the disk B is arranged to slide on the shaft through the use of a feather key F. When the two disks are in contact, they balance each other; but when separated, they introduce a centrifugal couple according to the weight of the pins and the distance between the disks, which can be varied while the apparatus is in motion. (2) A planetary arrangement by which the relative angular position of the body and the disks (or cage) can be varied while the machine is in operation. (3) The application of a principle whereby the disks (or cage) may be arranged to answer the problem of static balance as well as dynamic balance.

Static Balance

In the study of static balance, too much has been taken for granted. Static balance is not a trifling problem to be solved easily by placing a rotating body on parallel ways or rollers, as has commonly been supposed. While this balance can be easily found in the case of bodies of light weight or where the operating speeds are comparatively slow, there are much more difficult cases. For example, a gyroscope wheel that weighs about fifty pounds and runs at 10,000 revolutions per minute, or a turbo-rotor weighing 10,000 pounds and making 3600 revolutions per minute, cannot be balanced by placing the

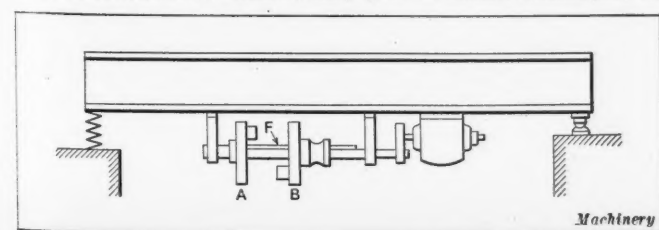


Fig. 2. Two-point Balancing Element

bodies on ways; and yet, unless static balance is perfect, no dynamic balancing machine can give reliable results.

There is a limit to the load that can be safely borne by the journals in contact with the ways. A safe load for each journal appears to be 750 pounds per inch of width per inch diameter of journal. For instance, if the ways are 1½ inch wide and the journal diameter is 10 inches, each side will carry almost 12,000 pounds without any danger of forming permanent flat spots.

The older theories of roller friction, as proposed by Coulomb, Morin and Dupuit, do not seem to lead to very reliable results; Resal's formula is probably much more reliable, and in simplified form, steel on steel, is:

$$f = 0.056 \sqrt{\frac{1}{1 + \frac{79}{D}}}$$

where f = length of contact of shaft with way, in inches;
 D = diameter of shaft, in inches.

The diagram in Fig. 3 has been roughly plotted to illustrate the probable sluggishness or residual unbalance that may remain in a body that has been brought into apparent balance by testing on ways. It is based on Resal's formula, and, as it is intended simply to illustrate the meaning of the formula, values have been exaggerated by plotting shafts of small diam-

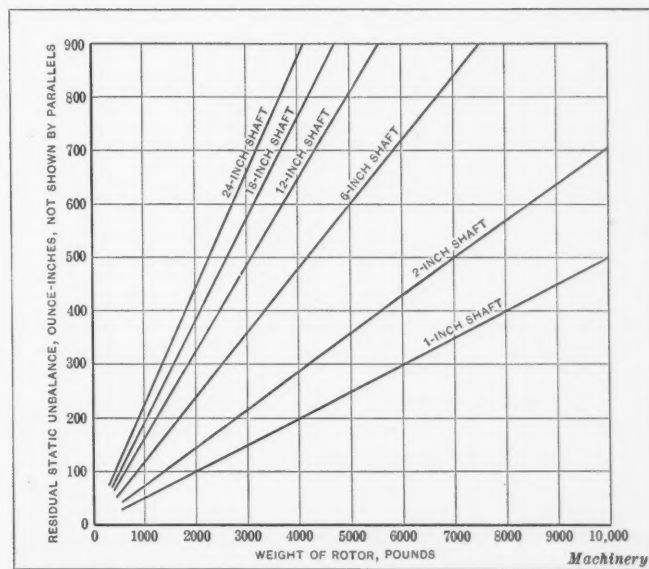


Fig. 3. Probable Residual Unbalance of Bodies balanced on Testing Ways

eter against weights altogether inconsistent therewith. The chart is easily read; for instance, if a rotor weighs 4000 pounds and the diameter of its shaft is 6 inches, the residual unbalance may be as great as 480 ounce-inches, or say 2½ pounds on a 12-inch radius. It is useless to put a body statically unbalanced to such an extent (or even to 50 per cent of this) on any dynamic balancing machine. Satisfactory results cannot possibly be derived from such tests. An actual case of residual unbalance, typical of many others, is of a shaft having a diameter of 2 3/32 inches, a weight of 66 pounds, and a residual unbalance of 0.844 ounce-inch. The balancing ways were made of cast iron, chilled and ground, and their width was 5/16 inch.

Considering the phenomenon of rolling friction from the standpoint of higher theories of elasticity, the following tentative formula was derived for residual unbalance:

$$M = 0.0004648 P \sqrt{PD}$$

where M = residual moment, in ounce-inches;

P = weight per unit of contact length, that is, per inch of combined width of ways;

D = diameter of shaft, in inches, steel on steel.

The constant may be considered to be rather tentative, but

¹Abstract of a paper read before the American Society of Mechanical Engineers in New York City, December, 1917, by N. W. Akimoff, Philadelphia, Pa.

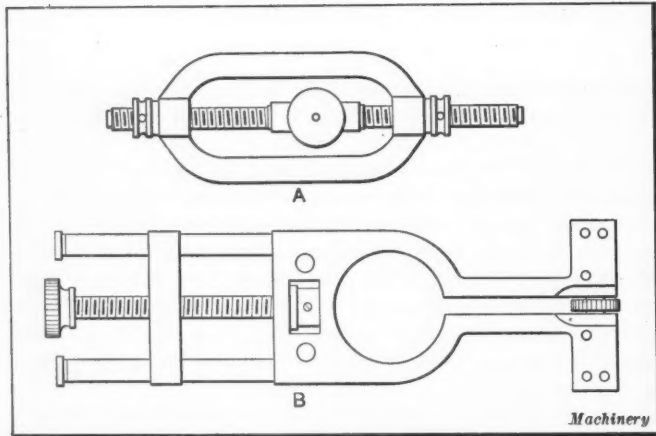


Fig. 4. Clamps used in securing Static and Dynamic Balance

with the advent of a machine capable of establishing perfect static balance it will not take long to find more reliable values for it. According to this formula, if an armature weighs 12,000 pounds and has a shaft diameter of 8 inches, the sluggishness or residual balance, when placed on ways 1 inch wide, will be:

$M = 0.0004648 \times 6000 \sqrt{6000 \times 8} = 611$ ounce-inches or over 3 pounds on a 12-inch radius. At 3600 revolutions per minute the centrifugal force due to such residual unbalance will be more than 14,000 pounds.

Use of Centrifugal Force in Balancing

The earlier machine for dynamic balancing was based on the introduction of centrifugal couples, created by the opera-

violent, and can be readily registered by any suitable dial-gage indicator. Here the body is imposing its own period on the frame, which thus performs what are known as forced vibrations of the same period. The problem is to adjust the speed of the body so that the period of such forced oscillation will be equal to that of the natural oscillation of the frame and body, that is, at rest. Of course, a clamp *K* can always be so adjusted as to nullify the oscillations of the frame.

Dynamic Balance

As regards dynamic balance due, in a statically balanced body, only to the presence of a centrifugal couple, the theory that this centrifugal couple is due to the fact that the centers of gravity of both halves of the body, cut through its center of gravity, do not lie on the axis of rotation is radically wrong. Take, for instance, a skeleton body, as shown in Fig. 5. Its center of gravity is exactly on the axis of rotation, as also are the individual centers of gravity of each half, to the right and to the left of *AB*. Yet such a body would be manifestly out of balance, dynamically. Inversely, a body would readily be imagined to be in both static and dynamic balance, although each of its halves were statically out of balance. The only correct way to characterize dynamic balance is to say that the products of inertia, containing the axis of rotation, vanish; or, to put it practically, that there is no centrifugal couple in any axial plane.

If one end of a rotating body, statically balanced but dynamically out of balance, is constrained or pivoted while the other end is arranged to float in a bearing supported by springs so that it may move, say, in a horizontal plane, Fig. 6, the oscillations of the body will be angular, as from *A* to *B*. Under these conditions the observer will be unable to tell whether:

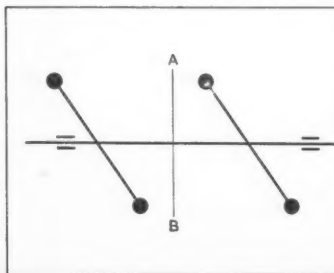


Fig. 5. Unbalanced Body with Center of Gravity lying in its Axis

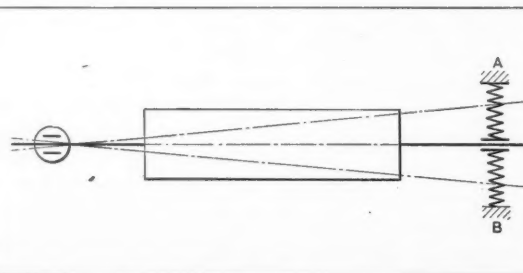


Fig. 6. Rotating Body with One Bearing pivoted and One floating between Coil Springs

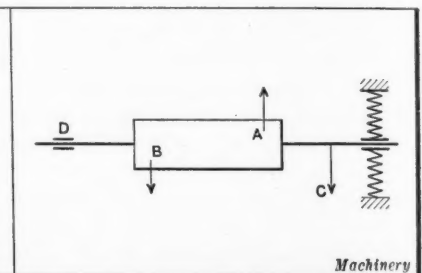


Fig. 7. Centrifugal Couple balanced by a Centrifugal Force

tor to offset the effect of the disturbing centrifugal couple, constituting unbalance in the rotating body. While a machine for static balancing can be based on the same principle, a long study of the subject has led to the conclusion that the whole problem of balance, static and dynamic, can be reduced to the principle of a single centrifugal force acting on a properly constrained body. Such centrifugal force can be created by the operator, within a rotating body, by such means as clamps, of which two designs are shown in Fig. 4. These clamps should be carefully made and calibrated so that the centrifugal force may be given as a function of some linear dimension, read directly, or measured by an accurate scale. One clamp *A* is easier to make and check for accuracy; while the other *B* is much handier for quick adjustment on the shaft of a rotating body.

In order to register the effect of static unbalance of a body, or the correction introduced by means of a clamp, the body must be placed in such a condition that its oscillations are emphasized or magnified to an extent that they will be visible to the eye; otherwise its unbalance will only result in increased pressure on the bearings. Thus, in a badly unbalanced automobile engine, it is often possible to pick out a range of speeds where the engine will appear to work smoothly; and many electric motors with a badly unbalanced rotor will apparently run well, simply because their speed may be far away from that which will insure synchronism of the rotation with the oscillation of bearing supports.

Suppose a frame, suspended as shown in Fig. 8, is capable of a certain period of swinging oscillation. If the body, statically unbalanced, is operated at a speed corresponding to the period of oscillation, the oscillations of the frame will become

the vibrations are due to a force acting somewhere on the body or to a centrifugal couple, unless he knows beforehand that the body is in perfect static balance, under which conditions the vibratory effect can be due only to dynamic unbalance. This being the case, in view of the reaction of the constrained end, it is perfectly possible to balance the effect of a centrifugal couple by means of a centrifugal force. Thus, in Fig. 7, if the dynamic unbalance is assumed to be due to the couple *AB*, it will always be possible to select a centrifugal force *C* that will quiet the vibrating body, and because of its known distance from the bearing *D*, establish the exact value, sign and angular position of the disturbing centrifugal couple *AB*.

It is thus possible to utilize a centrifugal force to good advantage in finding both static and dynamic unbalance of

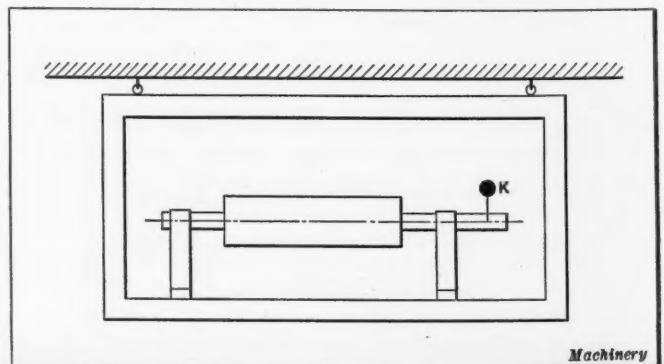


Fig. 8. Body supported in Swinging Frame for securing Static Balance

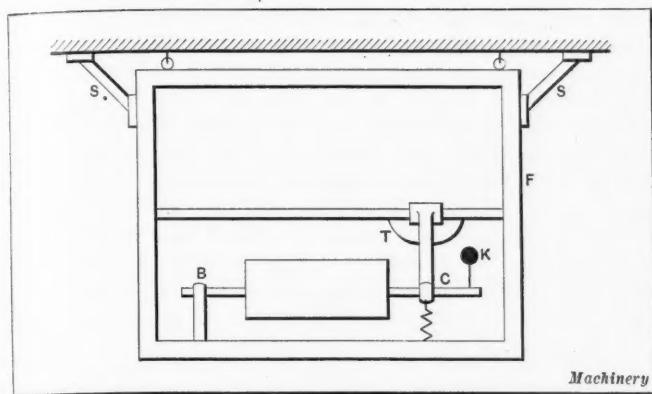


Fig. 9. Body with One Floating Bearing, supported in Rigid Frame for securing Dynamic Balance

bodies; and combining the principles illustrated in Figs. 6 and 8 gives a combination static and dynamic balancing machine.

Description of Improved Balancing Machine

A frame *F*, Fig. 9, supports the bearings *B* and *C* that carry the body. The frame has a swinging period of its own and the bearing *C* may be locked, so that it acts exactly like the right bearing *B*, or it may be allowed to float in a vertical plane, bringing into play certain resistances, springs that oppose its deflection from the neutral, vertical position. The correcting centrifugal force is indicated by *K*. Such a system is known as a system with two degrees of freedom and is capable of two kinds of motion: swinging of the frame, the bearing *C* being maintained rigid, and swinging of bearing *C*, the frame *F* being maintained rigid by brackets *S*. The most general motion consists of a combination of these two motions.

The operation of such a combination machine is very clear. In order to secure static balance, the bearing *C* is locked and the frame supports *S* are unlocked. Then, by adjusting the magnitude and direction of *K*, the body oscillations of the frame *F* are reduced to zero, thus establishing the exact value and sign of static unbalance in ounce-inch units. As soon as this has been corrected, the frame *F* is locked and the bearing *C* unlocked; then the centrifugal force *K* created by a suitable adjustment of the clamp can be made to correct the

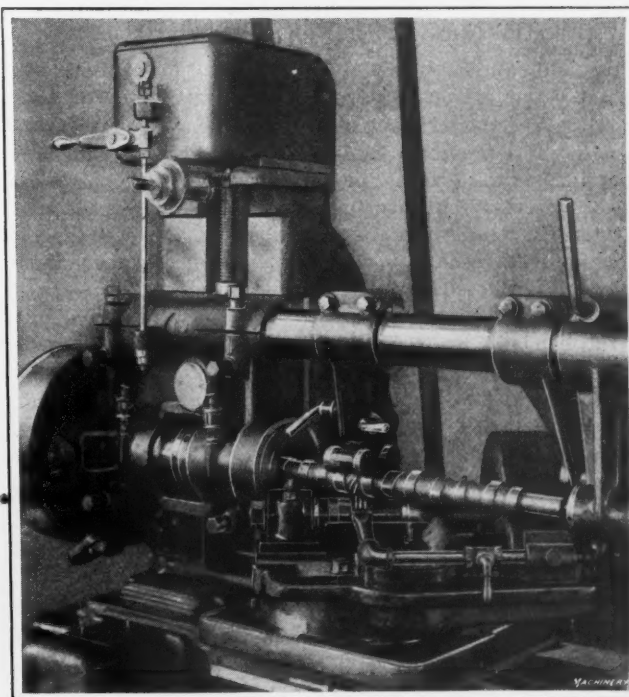
body for dynamic unbalance, as illustrated in Fig. 6. The advantage of basing the results on the centrifugal force instead of on a centrifugal couple is manifest; the former is a fundamental and the latter a derived unit, so that the former is capable of much greater accuracy in adjustment and of more direct application than the latter.

Fig. 10 illustrates a balancing machine built in accordance with the scheme of Fig. 9. The yielding support, on the right, and the frame are easily adjusted. The motor is of one-third horsepower capacity and operates the body, through a countershaft, by a rubber belt. The balancing clamp is on the extreme right of the crankshaft. The oscillations are read by means of ordinary Starrett dial gages, graduated in thousandths of an inch. The precision that can be secured on such a machine is almost uncanny; it enables one to see the sluggishness of the method of balancing on ways, and therefore the absolute lack of precision of dynamic balance that might be based on such results. A well-designed clamp is very easily handled and its correct position can be established in a few minutes. Its indications are capable of tabular interpretation, so that the operator has merely to carry out the simple instructions worked out beforehand. Of course, it is clear that such a machine can be built for any size of body or for any speed that may be desired.

* * *

HOBBING SPIRAL GEARS WITHOUT TRAVERSING HOB

An unusual gear-hobbing operation is shown in the accompanying illustration, which represents the cutting of a spiral



Cutting Narrow Spiral Gear in Center of Camshaft without traversing Hob

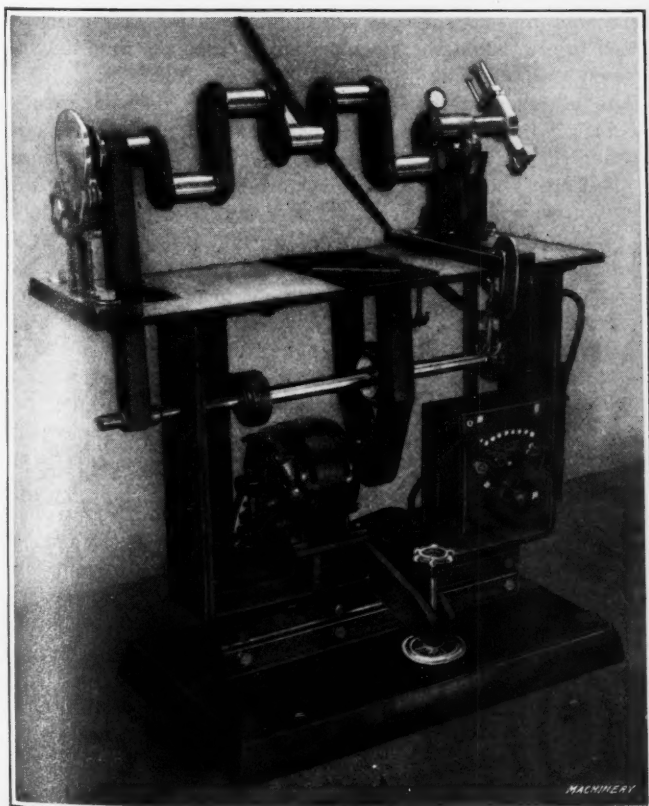


Fig. 10. Combined Static and Dynamic Balancing Machine

gear in the center of a long camshaft on a Barber-Colman gear-hobbing machine. The bearings on each side of the gear made it impossible to cut the teeth by traversing the hob across the face of the gear in the usual manner. The gear face, however, was so narrow that it could be cut satisfactorily by simply feeding the work down onto the revolving hob. The outer end of the camshaft is supported by a center from the overhanging arm and the other end is held in a spring collet inside the spindle, the collet being opened or closed by a handwheel at the rear of the machine. The thrust of the cut is taken by a special form of steadyrest, consisting of four hardened rollers which are in contact with bearing surfaces on each side of the gear. These rollers are supported from the overhanging arm, as may be clearly seen in the illustration.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

THE DAYLIGHT SAVING BILL

Practically all Europe has turned the clock forward one hour to make better use of the daylight in the early morning hours and to save artificial light at night. The "daylight saving" bill now before Congress, having a similar purpose, is of great importance at the present juncture when the shortage of coal makes it necessary to save fuel whenever possible. Statistics show that England saved 300,000 tons of coal in the summer of 1916 by turning the hands of the clock forward one hour.

It would be possible, but hardly practicable, to start work an hour earlier and accomplish the same result without moving the hands of the clock; but this simple expedient makes it easy for everyone to begin work an hour earlier, avoids any change in the railroad time-tables and other schedules and, besides saving fuel, allows an extra hour of daylight in the evening for recreation in the open air after the day's work. The objects of this bill can be accomplished with a minimum of trouble and no expense, and we hope it will become a law.

PROGRESS OF MACHINE TOOL DESIGN

The effect of the motor car on machine tool design is an interesting example of the manner in which one industry reacts on another. The first motor cars were built after the fashion of other machines, low-carbon steel being used for the shafts and cast iron for the gears. Each bearing was oiled individually through its own oil-cup, shafts were cut with a single spline for sliding gears, and all the mechanism was interdependent as regards manufacture and assembly. The early history of motoring was a story of breakdowns and expensive repairs. To start on a long trip was to begin an adventure quite likely to end in mishap more or less serious. The shocks and strains of road locomotion, even at moderate speeds, soon caused fatigue and failure of some of the vital parts in the engine and transmission. It was quickly realized that cast iron would not do for gears nor machine steel for shafts; that more efficient means of lubrication and separation of the mechanism into its essential units were necessary. Then began the demand for machine tools that could work heat-treated alloy steels at an economical speed. Again was the failure of machine steel and cast iron re-enacted in lathes and milling machines. The reconstruction found necessary in the motor car was also necessary in the machine tool. Heat-

treated steel gears and shafts, compact and strong gear-shifting devices, multiple splines, separation of the feed mechanism into demountable units, automatic lubrication of bearings and other features of modern motor cars are being incorporated more and more in the latest types of machine tools, especially the milling machine. The result is a long-lived machine that operates with less friction than its predecessor and seldom breaks down. A break is less serious also, as the defective part can be removed and replaced without tearing down the whole machine. The next important step in machine tool improvement will be the general use of ball and roller bearings and the standardization of design so as to permit of the more general manufacture of interchangeable parts.

* * *

COOPERATION WITH THE TOOL ENGINEER

To design a machine that will work well and that will be also practical to manufacture comprises two distinct problems. No machine or apparatus should be perfected to the state where it is to be manufactured without the co-operation of the tool engineer, who should be given opportunity to study the design and modify it so as to reduce the cost of manufacture and provide for its efficient and rapid handling in the shop. The addition of a lug, the thickening of a frame, the change of location of a bolt hole or any one of many other modifications may mean all the difference between a slow, expensive job and one that can be turned out quickly at a minimum of cost. The machine designer is usually quite jealous of his design and slow to let anyone tinker with his pet ideas, but he should recognize the fact that it is one thing to design a machine to secure the maximum mechanical efficiency, and quite another to design it to secure the maximum manufacturing efficiency.

* * *

ELIMINATE UNNECESSARY WORK IN WAR TIME

It is unfortunately true that a great deal of unnecessary work is frequently done in the large industrial plants, which represents a loss both in peace and war times. This loss is theoretically individual under normal conditions, but under present conditions it affects the entire nation and should be eliminated wherever possible. In machine building, time should not be spent on unnecessary finish or unimportant refinement of measurements. Jigs and fixtures should never be finished on any surfaces where finish is not absolutely required in order that the work for which they are used may be properly performed.

It requires courage to change customs and ignore precedents, but during these critical times customs and precedents must go when they involve useless labor. Systems should be pruned of all unnecessary red tape, and forms and reports divested of all information except what is of actual value for future reference. Care should especially be taken to see that only necessary information is required and placed on record, because procuring information that is not to be used is a waste. Inspections will often prevent the collection of data that will never be referred to, although there may not be many cases like the one cited by an efficiency engineer who recently found in one large plant a highly developed cost system requiring the time of four men to compile, the data for which was filed in cabinets that had never been opened except to add other data.

Unnecessary correspondence should be avoided. Many communications require no answer, and the sender expects none except in reply to an inquiry or in the case of important letters which may be considered as forming part of an agreement. Even such correspondence may be considerably reduced.

The difficulty of obtaining efficient help of all kinds under war conditions makes this an opportune time to examine the work of every individual in your organization so as to determine what part, if any, can be economically dispensed with. In the shop the same thing may be true. Foremen and workmen, unless they are carefully looked after, are likely to continue unnecessary finish and refinement on their work, which should be dispensed with.

THE DESIGNING ENGINEER

BY JOSEPH W. WUNSCH¹

It is the intention to review here the most common troubles encountered by the designing engineer. He is frequently confronted by problems in which duty, conscience, and common practice do not quite coincide; some solutions of these problems are suggested. What do you imagine are the thoughts of a designing engineer when an inventor or manufacturer steps into his office, pulls out some patent letters, and after saying what that invention does and others don't do, finally asks for just a "few rough sketches" for the machinist, to make the first machine? The man does not care to have assembly drawings at all. He does, however, expect, possibly within a few days, drawings warranted to be without error, and that will insure the correct working of the machine.

Conscientiously, the engineer may tell his visitor that a perfect set of drawings of a special machine, made within a few days, is impossible of accomplishment; and as to guarantees, if his last month's rent is paid, the engineer may have the courage to tell the man that they are not customary, unless especially paid for. After studying the invention, the engineer may also decide that the necessary drawings will cost approximately \$500. His visitor is dumbfounded. He can hardly understand why they should be so costly, especially as the patent drawing, with all frills and fancies, costs only \$5 and there is lots of room for argument between \$5 and \$500.

A large number of manufacturers, including many machine builders, do not appreciate creative designing work. At any rate, that may fairly be concluded from their attitude when they have to pay for such services. As a rule, they consider bills rendered for designing service too high, no matter how modest those charges may be. If the manufacturer takes this stand, it is hardly fair to expect the amateur inventor to be more reasonable. One of the common sources of disagreement between the designer and his client is the latter's inability to differentiate between designing a new machine and a standard machine. Another source of disagreement, even a more serious one, is the fact that the client expects the drawings to be entirely devoid of error, and the working of the first machine, upon assembly, to be guaranteed. Given sufficient time, these expectations might be realized, but is the client willing to pay the premium for such insurance? A conscientious and complete design of a new machine usually requires more labor, expressed in time, than the building of the machine in the shop. In fact, assuming no ulterior motives on the part of the designer, the cost of building the machine in the shop is, to a certain point, inversely proportional to the time spent on the design in the drawing-room; and it is cheaper to find mistakes there than in the shop.

The ethical codes of various engineering societies show that the engineer is constantly striving to establish a code of conduct similar to that of the older profession of medicine. There is a close analogy between the problems that confront the physician and engineer, which may be classified in the departments of research, original creative work, and routine work. The field of general practice in both professions is so broad that specialists must frequently be consulted. Incidentally, attention may be called to the quackery from which most professions have to suffer, and this is particularly true of the engineering profession. While the physician is protected by the state and his organizations, the engineer has practically no equivalent support. It is true that he may often easily acquire superficial recognition when he affixes to his name a number of letters, which, translated into the language of the layman, means that he is a member of various societies because he is able to pay his dues.

Another serious problem of rather frequent occurrence resolves itself into the question: Should an engineer give his client what he asks for or what he needs? When an inventor lays his ideas before an engineer and asks him to develop them into a machine, should the engineer inform the inventor that his ideas are not practical, thereby incurring his wrath and utter contempt, or should he design a costly machine that is finally to land in the junk heap? Or should an engineer

gratify the request of the small-shop man, who says that all he needs is a "couple of sketches," to build his machine? He says that he cannot afford to pay for assembly drawings, and that they are useless anyway. If an engineer doesn't do as he is asked, he loses the job, and if he does, he will sooner or later hear of violent curses and sneers, by the fraternity of "practical men," on the engineering profession in general, and this engineer in particular. That is the ultimate stage in the evolution of the sketch-built machine, despite the story of the machine that Sammy and his boss built, without drawings, even without sketches. It was put together and worked without a hitch. The writer likes this story, it is a perfect shop story. It can be molded, tempered, and adjusted. It can be modified to suit any shop, machine or condition, with the added advantage that it may be kept in stock for repeated use.

In general, drawings should be accurate, legible, and in appropriate form for the purpose intended. To show shade lines and other unnecessary adornments on a shop drawing, is a waste of time; and to show two projections in a drawing where at least three are necessary, is worse practice. There seems to exist a general lack of appreciation of the value of proper assembly drawings and a sufficient number of detail drawings. The opinion apparently prevails that it is more efficient for the designer to hang around the shop as the work advances. In a majority of cases, the need of such supervision is merely the consequence of incomplete and inaccurate designs; it should not be at all necessary for the designer to supervise the execution of the work in the shop. When building a standard type of machine, his presence should not be required even when putting the machine into operation.

The natural development of a new type of machine may be properly divided into three stages, which are: the creative and experimental, the development, and the standardization. A perfect product cannot be approached if any function in any of these stages is neglected. The few records of first drawings that are extant and accessible are immensely interesting and instructive. Designs of machines in the process of development are indeed rare, and owe their existence to lucky accidents. In our literature, permanent and otherwise, first drawings are not considered at all. Drawings therein are of the final product and may be properly called post-mortem designs, inasmuch as the valuable matter of the stage of development is withheld from the reader. Designs of special machinery, which often represent months and even years of designing, embodied in a beautifully proportioned machine of the most ingenious mechanisms, are usually buried in the blueprint bin of the machine shop constructing the required number of machines, and never see the light of day. The inestimable value of such a design as a text on machine design is thus lost forever. Only in rare cases can the publication of such first drawings be of any harm to the designer or owner of the machine. Does it harm a physician to acquaint his colleagues with details of an interesting case even if the report ends "the patient died?" This brings to mind the great number of machines that never reach the market and of which no information at all is extant. These designs are often mines of valuable data and experience and their utility to the designer of new machinery can hardly be estimated.

* * *

According to the *Engineering News-Record*, conserving the food supply of the country by turning city garbage into alcohol instead of using grain or potatoes for the purpose is a promising possibility established by carefully conducted experiments reported from the garbage-reduction plant of Columbus, Ohio. The experiments show that one ton of Columbus green garbage will yield 4.8 gallons of 95 per cent alcohol of satisfactory quality. Estimates indicate that a \$36,000 plant would produce from the 20,000 tons of garbage treated annually at the reduction works a total of 96,000 gallons of alcohol, giving a profit of 42 cents per gallon at war-time prices, or 30.5 cents under normal conditions. A year's garbage, the tests indicate, would yield as much alcohol as could be produced from 33,600 bushels of shelled corn, 39,500 bushels of wheat, or 110,000 bushels of potatoes.

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MODERN DRILLING PRACTICE—2

SINGLE-PURPOSE CLUSTER TYPE MULTIPLE-SPINDLE DRILLING MACHINES—STATION TYPE MACHINES—APPLICATIONS OF INVERTED DRILLING PRACTICE FOR DEEP-HOLE WORK

BY EDWARD K. HAMMOND¹

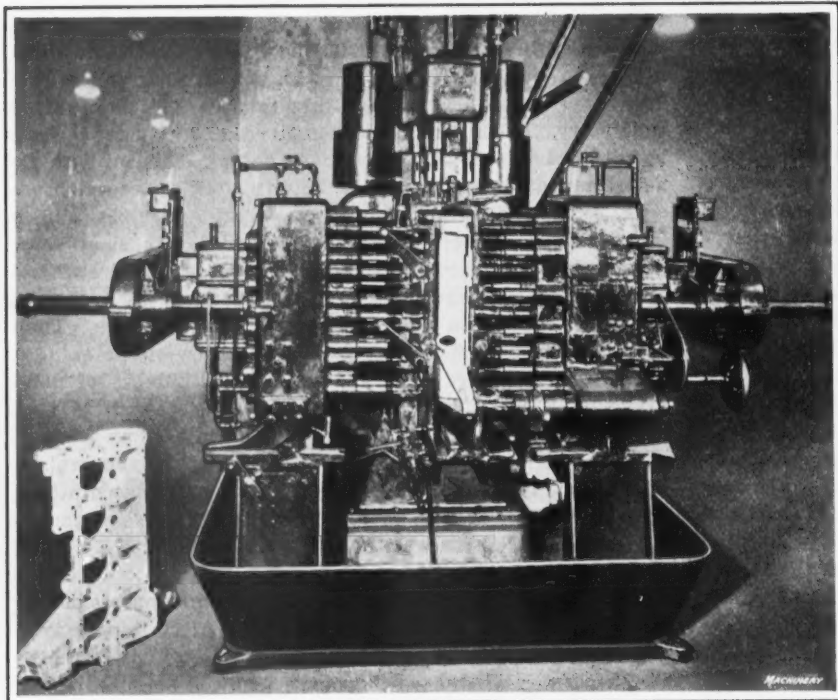


Fig. 22. Foote-Burt Three-way Multiple-spindle Drilling Machine for drilling Eighty-four Holes in Automobile Crankcase at One Setting

IN addition to the universal multiple-spindle machines described in the January installment, there is a very important group of cluster type multiple-spindle drilling machines which are designed and built to meet the requirements of specific manufacturing operations. In these machines the spindles are not usually made adjustable, because they are intended for one given class of work and each spindle is properly located to drill the particular hole in the work for which that spindle has been provided. Fig. 22 shows a three-way multiple-spindle drilling machine built by the Foote-Burt Co. for use in simultaneously drilling all of the screw holes in the upper half of a Willys-Overland crankcase. The material is aluminum, and this machine provides for drilling eighty-four holes at a single setting of the work. An idea of the remarkable rate of production secured through the possibility of simultaneously drilling such a large number of holes will be gathered from the fact that 480 crankcases are drilled in an eight-hour working day. This machine is so designed that the different sizes of drills are driven at approximately the correct speed and feed.

Special-purpose multiple-spindle drilling machines of the cluster type are built for a great variety of work, although the automobile industry represents the most important field in which these machines are employed. The reason for this is that it would not pay to invest in an expensive machine of this kind unless the volume of work to be drilled were sufficiently great so that it would be found profitable to build special machines for handling the work. Among the parts which are frequently drilled on special-purpose multiple-spindle drilling machines, the following may be mentioned: cylinder blocks, transmission cases, flywheels, crankcases, crankshafts, differential frames, wheel hubs, cover plates, etc.

¹Associate Editor of MACHINERY

Drilling, Reaming and Counterboring Rifle Floor-plates

Fig. 23 shows two Langelier multiple drilling machines used in couples for drilling, reaming and counterboring four holes in the floor-plate of a foreign rifle. The operations are performed without removing the work from the jig. The drilling is done with the machine at the left in two operations, and the reaming and counterboring with the machine at the right in two operations. Fig. 24 shows the floor-plate. Three of the holes are drilled, reamed and counterbored; the fourth is only drilled. The holes are drilled half way through from each side, the meeting of holes not being important, as the floor-plate is afterward slotted as shown by the dotted lines. To produce the greatest possible output from these machines, an operator is required for each machine, while a third loads and unloads the jigs. A set of three jigs is used. Thus the machines are continually at work. Fig. 26 shows the lay-out of spindles in the drilling head for the two drilling operations. This head is in the machine to the left in Fig. 23. The group of four spindles that carry the 5.1-millimeter and the three No. 17

drills is used for the first operation with the cover side of the jig down. The four that carry the 5.1-millimeter and the three $\frac{1}{8}$ -inch drills are used for the second operation with the cover side up. The $\frac{1}{8}$ -inch holes are not reamed. The jig is then carried to the second machine. Fig. 27 shows the lay-out of spindles in the drilling head in the machine to the right in Fig. 23, which is used for reaming and counterboring. The group of three spindles carrying the 0.178-inch reamers do the reaming with the cover side of the jig down. The group of spindles carrying the two 0.275-inch and one 0.315-inch counterbores do the counterboring with the cover side of the jig down.

Fig. 25 is a partial side elevation showing the drill head with its sub-jig attached and the jig on the table of the

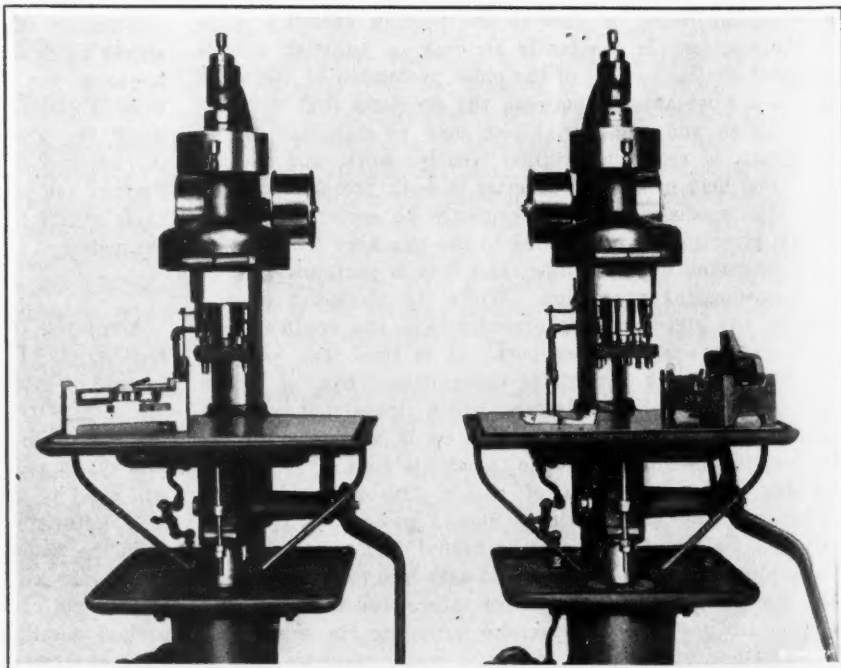


Fig. 23. Langelier Multiple Drilling Machines used in Couples for drilling, reaming and counterboring Holes in Floor-plate of Rifle Receivers

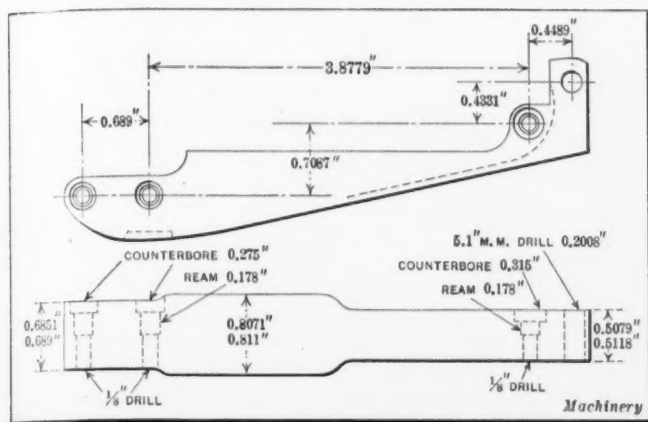


Fig. 24. Rifle Receiver Floor-plate which is drilled, reamed and counter-bored in Machines shown in Fig. 23

machine in position for the first drilling operation. The sub-jigs on the two machines are the same in principle. The bushings in the sub-jig guide the tools, and the bushings in the jig guide the sub-jig. By this method, each of the drills, reamers or counterbores has its own guide bushing, and the use of interchangeable slip bushings in the jig is avoided. The sub-jig is attached to the drill head under the compression of a spring. When the sub-jig comes in contact with the work jig, it is forced upward while the drilling, reaming or counterboring takes place. The sub-jigs can be quickly removed by unscrewing two tapering thumb-pins so as to provide free access to the tools if required. All the spindles are provided with adjusting screw collets so as to compensate for grinding of tools, also for individual adjustment for depth of holes. The jigs are of the swing cover type, compensating means and stops being incorporated for accurately locating and holding the work while it is operated upon. The machines are of the round column and base type. The table has a working surface of 21 inches by 14 inches, which is ample for the handling of the jigs. It is trunnioned into a supporting arm that is clamped to the column and can be adjusted to the required working position. The trunnion of the table has a rack which meshes with a pinion shaft having bearings in the supporting arm and to which is attached the long feed hand lever. A single feed stop is provided for the table for both operations.

Station Type Multiple-spindle Drilling Machines

In Fig. 21 in the January installment there was shown an illustration of a battery of Baush multiple-spindle drilling machines used in conjunction with a traveling jig which carried the work from one machine to another in order that advantage could be taken of the possibility of performing a number of groups of operations without the necessity of resetting the work. When the importance of the savings that are possible through the use of such an arrangement has been fully appreciated, it will be apparent that a still further benefit would be secured by the combination of different groups of spindles in a single machine that would provide for saving time by avoiding the necessity of frequent resetting of the work, and at the same time economizing floor space through having the entire outfit contained in a single unit. This is the idea that has been successfully accomplished through development of the "station type" of multiple-spindle drilling

machines which are built by the Baush Machine Tool Co. Machines of this type were first constructed for the use of the Ford Motor Co. in drilling all of the holes that are required in flywheel castings. The complete machine for doing this work is shown in Fig. 28, and Figs. 29 to 31, inclusive, show, respectively, the loading station where the work is set up on the machine, a view of two multiple-spindle drill heads, and a view of heads equipped with tools for the performance of drilling and reaming operations.

In operating the machine, each flywheel is placed on a supporting block and secured by means of an expanding center. The loading station on the machine is illustrated in Fig. 29, and in this view the wrench used for expanding the center on which the flywheel is held will be clearly seen in position. The counterbore in the wheel is used to locate the work under each jig, this result being obtained by a tapered leader which enters the counterbore as the jig at each station on the machine comes down to the working position. In addition to this counterbore, there is a flat dowel in the supporting block that registers between two jaws on the extreme outside portion of the jig, thus securing the wheel against rotation. The feed is accomplished by means of a barrel cam which is of the correct form to give a quick approach and the desired rate

of feed and return. By employing different cams suitable rates of feed can be employed for the tools in different heads. The table is rotated by a mechanism which also lifts it, thus allowing the weight to be carried on a center pintle, while it is in motion, and the provision of ball bearings in this connection makes it possible for the table to be easily moved. A hardened steel locking bolt is provided, which is actuated by a cam and comes into play just before the table is lowered to its working position, where the bolt locks the table in place.

When in the working position, the table rests on a circular rail which is slightly smaller than its outside diameter, this rail being carried up inside of a flange at the periphery of the table to protect the bearing from chips. One central oiling system is provided which delivers lubricant to all bearings, the pump taking the oil from a tank in the base and circulating it through a system of piping provided with return connections. There are eighty-one drilling, counterboring and reaming operations to be performed on the Ford flywheel, and with this machine it is found possible to perform all of these operations in fifty-four seconds. Each machine has a capacity for drilling 500 flywheels in an eight-hour working day, the

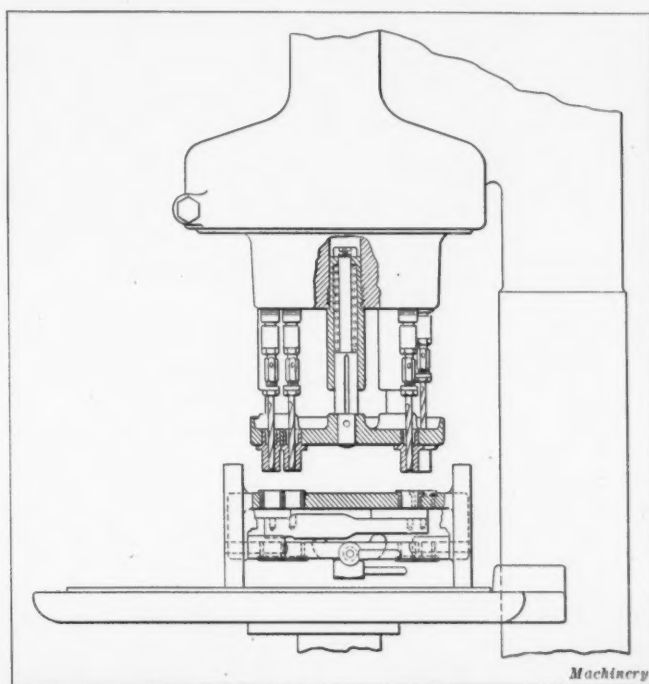


Fig. 25. Partial Side Elevation of Drill Head used on Machine at Left in Fig. 23, showing Sub-jig and Jig in Position for First Drilling Operation

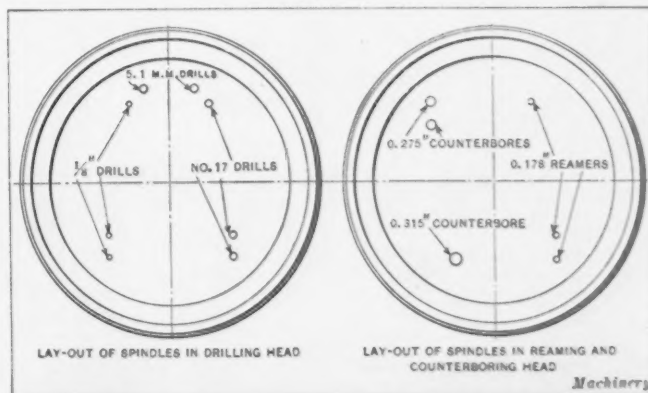


Fig. 26. Lay-out of Spindles in Drilling Head

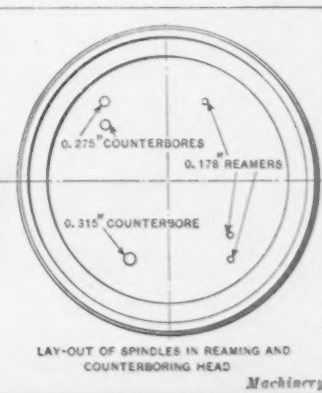


Fig. 27. Lay-out of Spindles in Reaming and Counterboring Head

actual rate of production being 510 flywheels in 450 minutes. The operations consist of drilling sixteen $21/64$ -inch holes in the inner circle through $1\frac{1}{2}$ inch of metal, and sixteen $1/4$ -inch holes in the outer circle half way through the same thickness of metal; second, counterboring the sixteen holes in the inner circle to a diameter of 0.386 by $3/16$ inch deep, and drilling the holes in the outer circle through the remaining metal, a 0.204 -inch drill being used for this purpose which cuts through $7/16$ inch; third, counterboring three half round faces 0.936 inch in diameter by $3/8$ inch deep in the hub of the wheel; fourth, drilling four holes 0.386 by $5/8$ inch deep, two holes $27/64$ by $5/8$ inch deep, and three holes $21/32$ by $7/8$ inch deep; fifth, reaming three holes 0.675 inch in diameter by $7/8$ inch deep and two holes 0.436 inch in diameter by $5/8$ inch deep.

While the discussion of the work of this machine is presented in connection with its application in machining flywheels of Ford motor cars, it must not be thought that this is a single-purpose machine, because there are a great many classes of work that could be handled on an equipment of this type with beneficial results. Not only is the use of this machine responsible for saving a lot of space in the shop, but it will be apparent that its use also presents the possibility of drilling holes on centers that would be too close for an ordinary multiple-spindle drilling machine. Where the

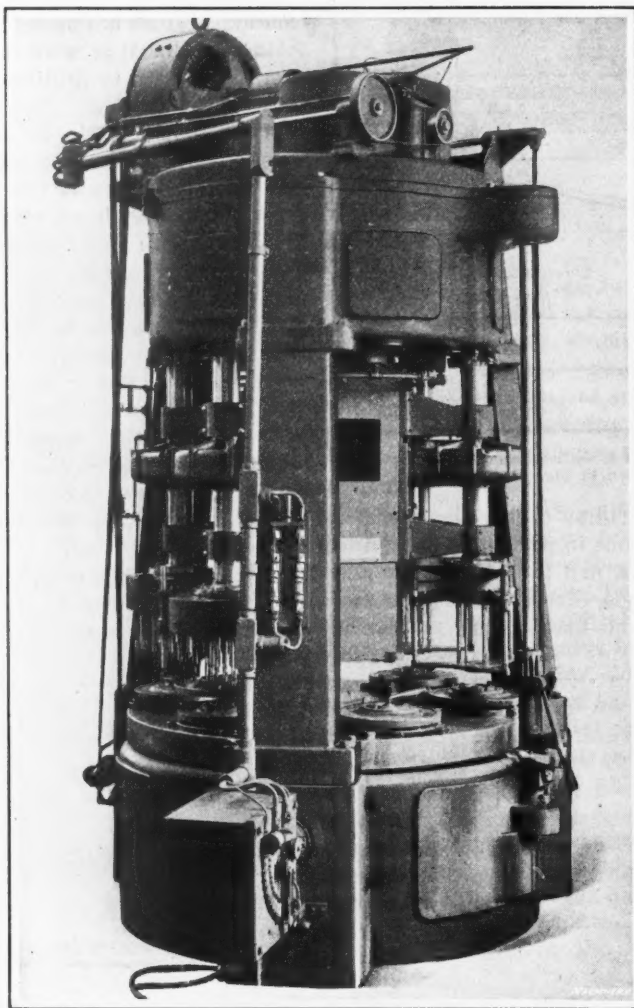


Fig. 28. Baush Station Type Multiple-spindle Drilling Machine built for performing Eighty-one Drilling, Counterboring and Reaming Operations on Ford Flywheels

center distance is so close that it would be impossible to arrange spindles in a cluster head to provide for drilling them with a machine of this type, one hole may be drilled by one head and the next hole by a following head, so that the question of distance from center to center becomes relatively unimportant. The multiple head feature also makes it possible for heavy and light drills to be grouped together in different heads, so that each size may be operated at suitable rates of cutting speed and feed. Different standard spindle clusters may be furnished to meet the requirements of different classes of work, and these heads may be readily removed to enable different ones to be substituted. The regular adjustable drill heads built by the Baush Machine Tool Co. can also be used to adapt the machine for more or less general classes of multiple drilling. A switch and starter are located beside the loading station, which enable the operator to control the motor with his left hand, while the feed mechanism is governed by a small lever at the right-hand side of the operating position. By means of this lever it is possible to stop all the feed motions of

the machine instantly, including the indexing of the table.

Application of Inverted Drilling Principle for Deep Hole Work

A deep hole is usually defined as a hole the depth of which is equal to at least five times the diameter, although some



Fig. 29. View of Loading Station of Drilling Machine shown in Fig. 28

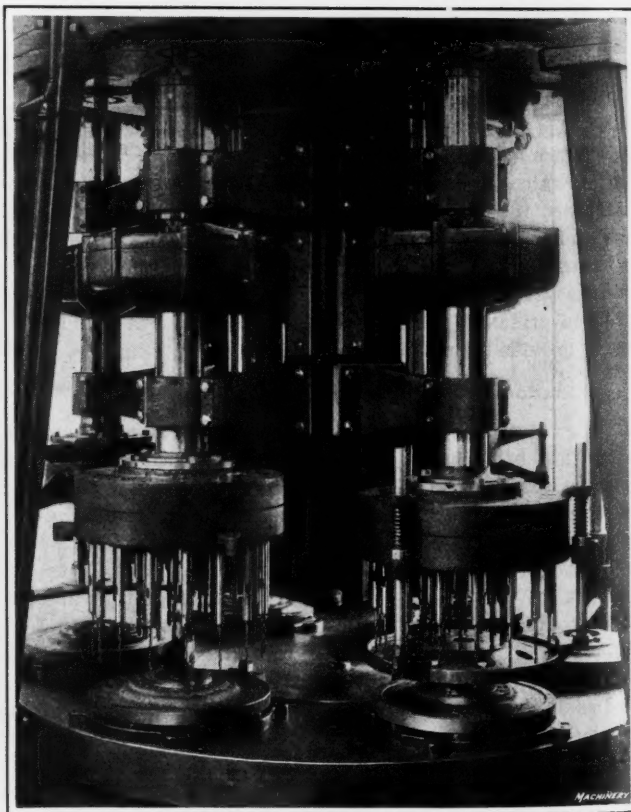


Fig. 30. Close View of Multiple-spindle Drill Heads

authorities define it as one in which the depth is equal to four diameters. In deep hole drilling, special precautions must be taken for two reasons: In the first place, trouble is likely to be experienced through breaking of the drill as a result of chips clogging the drill in the hole; and, secondly, further trouble may result through failure to obtain the desired cooling and lubricating action on account of having the chips prevent lubricant from reaching the cutting point of the drill. Numerous expedients are employed, but to provide for preventing trouble from chips clogging the drill in the hole, it is quite general practice to back the drill out of the hole at frequent intervals in order that the chips may be cleared from the drill. This also guards against an accumulation of chips preventing lubricant from reaching the cutting point. A better way to assure efficient lubrication of drills used in deep holes is to use oil-tube tools which are furnished with ducts that carry the oil or cutting compound direct to the point of the drill where its action is required. Recently it has become quite general practice to adopt the use of inverted drills for deep hole work, because it has been found that where an inverted drill operates from below the work, it is a much easier matter for the chips to clear themselves from the hole. Where this inverted drilling is employed, it is not often necessary to resort to the practice of backing the drill out of the hole at frequent intervals, in the manner which has just been mentioned. The following examples of inverted drilling will clearly show the benefits of this method for drilling deep holes.

The station type drilling machine shown in Fig. 32 was designed and built by the Baush Machine Tool Co. for drilling the bolts and receivers of military rifles. At first sight, this machine may appear similar to the preceding type for drilling automobile flywheels, but as a matter of fact there are noteworthy points of difference. On the preceding type of machine the drills are carried in multiple heads and the work is mounted on an indexing table supported by the base of the machine. In the present case, it will be seen that the work is supported in fixtures carried by the spindles of an indexing turret, while the tools are carried on a fixed spider. In both cases the drive is from above, but in the case of the present machine the work revolves and the tools remain stationary. Advantage is taken of the inverted drilling principle, which is beneficial in clearing chips from the work. Feeding the drills to the work is accomplished by raising the spider on

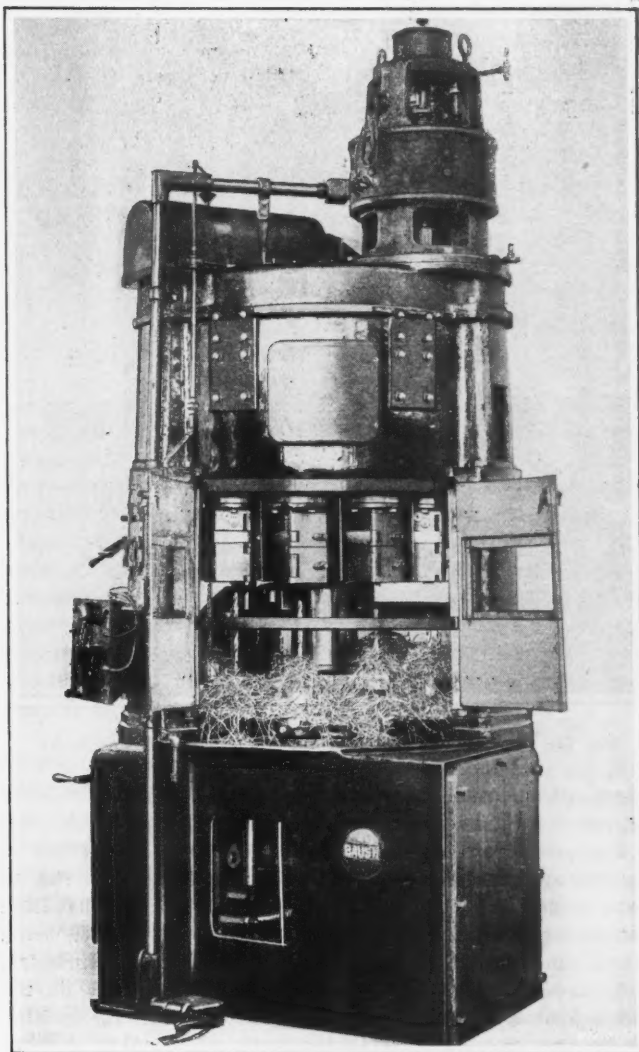


Fig. 32. Baush Station Type Drilling Machine for drilling Rifle Bolts and Receivers

which the drills are carried. The drills increase progressively in length in order to obtain the required depth of hole, and it will, of course, be evident that for each indexing of the work one finished part is produced. The use of various lengths of drills serve the same purpose as backing out the drill at the required intervals, which is the practice in deep hole drilling operations where a single drill is employed. On this machine the drills used are of the oil-tube type, which provide for delivering oil direct to the cutting point of the drill. Drive is provided by an electric motor at the top of the machine, from which power is transmitted to the spindles which carry the work-holding fixtures by means of a central gear meshing with pinions on each of the spindles. Feed motion is furnished by a barrel cam, which provides for raising or lowering the spider that carries the drills. Indexing is accomplished by rotating the turret that carries the work-spindles; and the release of the locking bolt that secures this turret in place, during the performance of each drilling operation, is accomplished by means of an edge cam carried at the bottom of the feed cam.

Fig. 33 shows a four-spindle gang drilling machine built by the Rockford Drilling Machine Co., which is equipped with two-jaw chucks mounted on the spindles so that work may be rotated by the spindles and fed down onto inverted drills which are held stationary on the table of the machine. The principle will be clearly understood by reference to the illustration. As in preceding cases, the advantage of this method of drilling is that the chips are cleared more easily from the deep holes than would be the case with the usual relation of the work and drill. The work consists of yoke forgings for universal joints, and these pieces are fed down over the drills so that, after the drilling operation has been completed, the end of the forging is faced by the stationary tool A, which will be seen in the holder at the base of each drill. The work to be drilled is a drop-forging containing 0.15 to 0.25 per cent of carbon, 0.30 to 0.60 per cent of man-

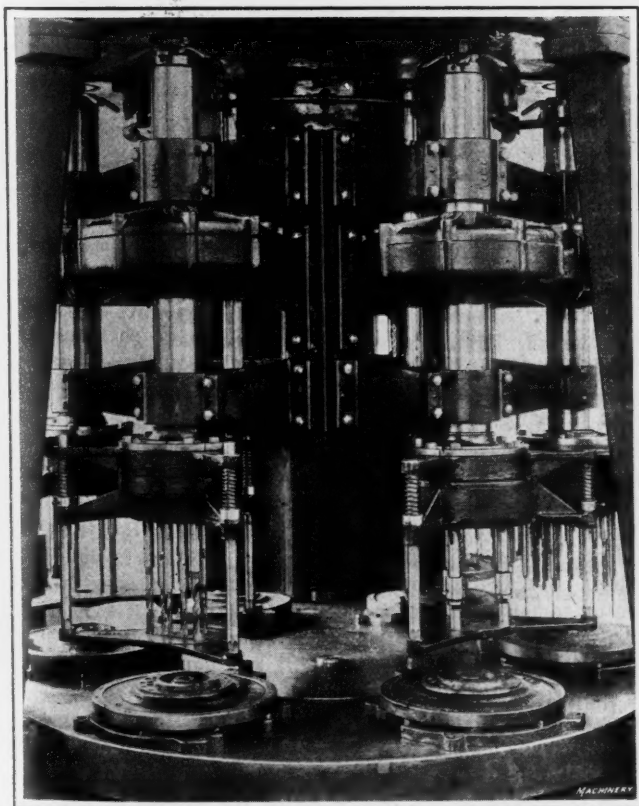


Fig. 31. Drill Heads equipped with Tools for Drilling and Reaming Operations

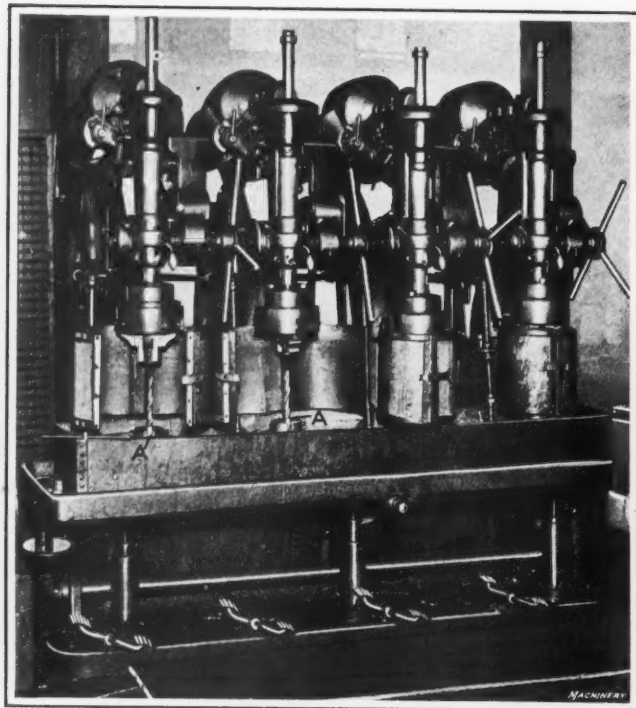


Fig. 33. Rockford Gang Drilling Machine employing Principle of Inverted Drilling

ganese, phosphorus below 0.045 per cent and sulphur below 0.05 per cent. The holes to be drilled are $7/8$ inch in diameter by $1\frac{3}{8}$ inch deep and approximately 1000 pieces are drilled on this four-spindle machine in a ten-hour working day. Fig. 34 shows a detailed view of the fixture provided for handling a somewhat similar job, although in this case, after being drilled, the work is turned on the outside and then threaded. As in the previous case the drill is held stationary on the machine table and a chuck carried on the drilling machine spindle provides for rotating the work and feeding it down onto the drill. After the drilling operation has been completed, the fixture is indexed to bring the cup turning tool, or hollow-mill, into the operating position to provide for turning the outside of the work; and after this operation has been completed, the fixture is again indexed to bring the Geometric self-opening threading die into position for threading.

Machining High-explosive Shell Blanks on the Drill Press

Fig. 35 shows an interesting installation of drilling machines built by the Barnes Drill Co. for machining 18-pound

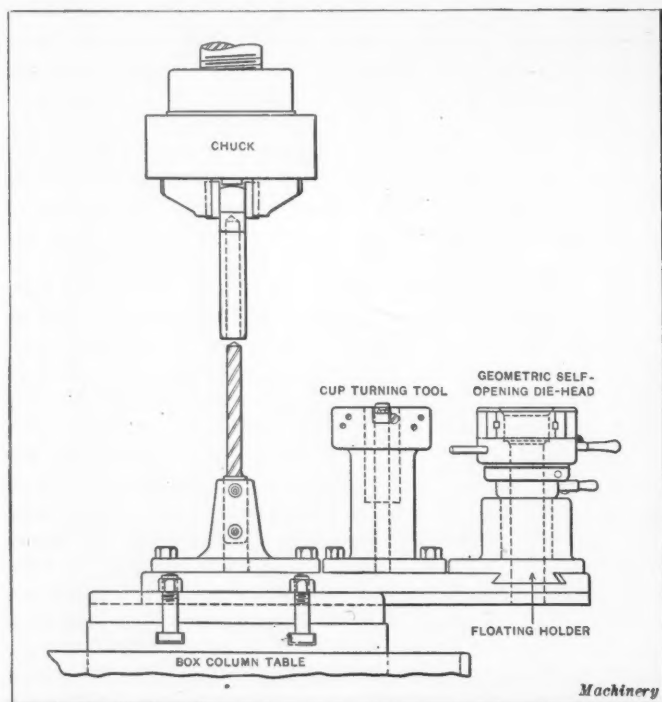


Fig. 34. Fixture for drilling, turning and threading Work

high-explosive shells, and Fig. 37 shows a close view of the tool equipment on this machine. Selection of this type of equipment was decided upon at the factory where the machines are used, due to inability to secure reasonable deliveries on the types of machine tools that would ordinarily be selected for the performance of machining operations of this kind. A battery of eight of these self-oiling 22-inch machines was installed, and the results obtained have been entirely satisfactory. It will be apparent that the shell to be machined is held in a fixture A secured to the drilling machine spindle, while the tools required for the performance of successive operations are carried on an indexing fixture mounted on the machine table. With this arrangement the work is revolved

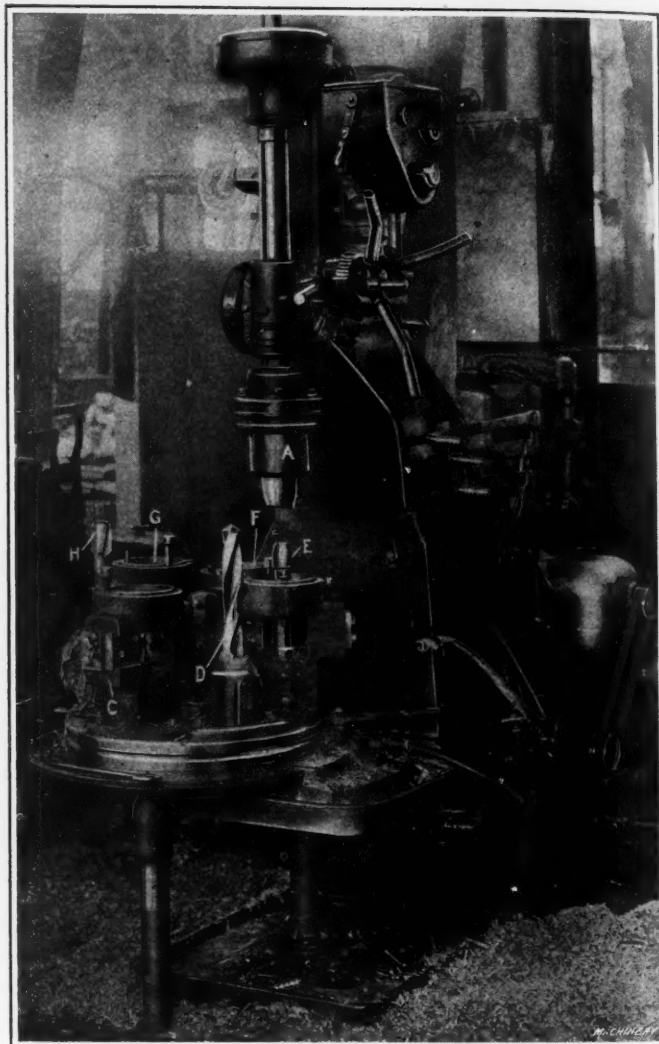


Fig. 35. Drilling Machine built by Barnes Drill Co. for machining 18-pound High-explosive Shells

and fed down onto a stationary inverted tool, so that advantage may be taken of the greater ease with which chips clear themselves from an inverted hole of this kind. After each operation has been completed, the tool-holding fixture is indexed to bring the next tool into the operating position. The first operation is to spot-drill and rough-form the nose of the shell with tools held in holder C. It will be seen that a guiding ring is provided for the work so that it cannot spring away from the cut. The operation is performed at 92 R.P.M. with a feed of 0.013 inch per revolution. The spotting is done with a short twist drill, and rough-forming of the nose with three turning tools, which are stepped so that they cut to different depths, leaving an irregular surface.

The second operation is to drill the hole in the shell to the required depth; for this purpose drill D is used, which is $1\frac{13}{16}$ inch in diameter. The drilling operation is performed at 145 R.P.M., with a feed of 0.013 inch per revolution. The third operation is to rough-ream the hole with reamer E, which is formed at the end to finish the bottom of the shell cavity to the required shape. The operation is performed at 37 R.P.M., with a feed of 0.093 inch per revolution. The fourth

operation is to finish-form the nose with a form cutter located in holder *F*, which is bronze lined. The spindle runs at 45 R.P.M., and is fed down by hand. The fifth operation is to cut the step and bevel on the nose of the shell. For this operation the tool is supported by a bronze lined tool-holder *G* and the machine is operated at the same speed and feed as for the fourth operation. The sixth and final operation is to finish-ream the hole in the shell with reamer *H*. Great care is required in the performance of this operation, as specifications for the shells require that when a light is dropped into the hole the surface will show a uniform polish in all places. The finish-reaming operation is performed with the spindle rotating at 37 R.P.M., with a down feed of 0.093 inch per revolution.

Drilling Lathe Spindles

The deep-hole drilling machine shown in Fig. 36 was built originally by the Charles Stecher Co. for drilling holes in the solid forgings from which machine tool spindles are made, and the first machine was used for drilling the spindles of the Stecher screw machines. Several machines of this design were subsequently sold to other machine tool builders for the same service. Recently this machine has been enlarged and its design has been altered to adapt it for drilling recoil cylinders, axles for gun carriages, and gun barrels and jackets for the smaller guns. The largest machines built to date have a bore through the spindle 8 inches in

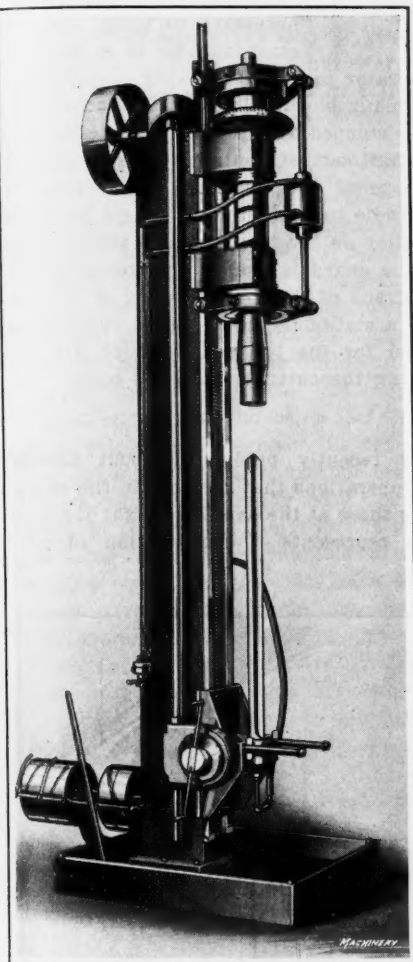


Fig. 36. Stecher Deep-hole Drilling Machine

diameter and a feed of 96 inches. These dimensions can easily be increased. This machine is used for roughing out the first hole from the solid forging and on finishing operations where wood-packed reamers are used. For roughing out holes from the solid, an ordinary drill point is used, inserted in a bar slightly smaller in diameter than the bore, and the bar is fluted for chip clearance. The vertical feature allows the chips to clear freely without the use of high pressure on the cutting compound, and it is not necessary to give special consideration to this problem, which is the chief source of trouble in drilling deep holes in a horizontal position. Drilling artillery axles in these machines with a drill point 3.185 inches in diameter, using 0.012 inch feed and driving the spindle at 48 revolutions per minute, the work is drilled to a depth of 57 inches without trouble from chips clogging, and as the work revolves, the hole is straight and concentric to the bottom.

The spindle is equipped with an air chuck at each end, controlled by an operating valve which is conveniently reached from the floor. The work can be lowered through the spindle with an overhead tackle, but where head room is limited the work can be placed on a carriage and raised through the spindle from below. An operator and helper can operate a number of these machines, depending on the nature of the work accomplished. Where wood-packed reamers are used, the reamer is drawn down through the work by a draw-rod and is guided



Fig. 37. Close View of Tool Equipment of Machine shown in Fig. 35

and held against turning by a rigid bushing above the spindle; or the work can be changed from the rougher to a special machine designed for reaming, which is constructed with the hollow spindle, in which the work is rotated, at the base end of the column and the drill carriage above, feeding the reamer down through the work and washing the chips ahead. By revolving the work, the best results are obtained, and the vertical lay-out permits the use of simple tooling, with consequent low tooling cost. The design of these machines permits of grouping the equipment, which is the ideal arrangement for handling four or five machines by one operator and helper without decreasing their production.

Horizontal Deep-hole Drilling Machine

The machine shown in Fig. 38 was designed for the special purpose of drilling the long small hole through the length of the steel block shown in Fig. 39, which is a part of a machine gun. The making of this part is started in the block form and the hole is put in first, as it is the most difficult to locate

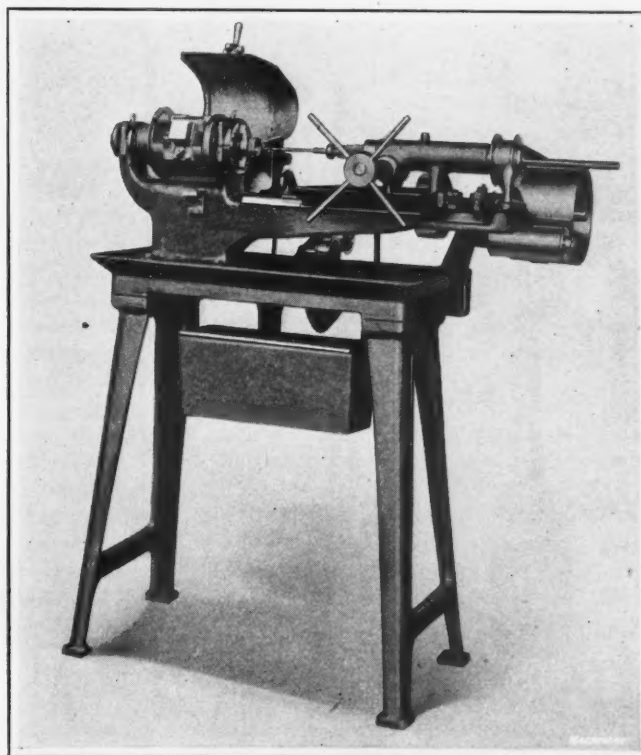


Fig. 38. Horizontal Deep-hole Drilling Machine

accurately. All the subsequent machining is gaged from the finished hole. The drilling of this hole is difficult, on account of its small diameter as compared with its length. The test for straightness of hole was the free fit of a hard ground arbor sized to 0.0005 inch less than the low diameter limits given in Fig. 39. To pass inspection, the pin had to drop through of its weight to the full length of the hole. The limits for this hole diameter

are 0.002 and 0.003 inch, and for depth, ± 0.007 inch. The leading feature of this machine is that both the work and tools revolve, the proper speed for each being determined from experimental tests. A set of seven tools, Fig. 40, is used to produce the hole. The large portion of the hole requires a spotting tool A, drill B and reamer C, the reamer having a spotting tool on its end to start the middle hole. The middle hole requires a drill D and reamer E, the reamer also having a spotting tool on its end to start the small hole. The small hole is drilled with drill F and reamed with reamer G. Each individual tool is fitted with a knurled taper socket lock shank that permits the tools to be quickly interchanged and locked firmly in place on the tailstock spindle.

The tailstock has two drilling positions, the outward position being used for the three operations on the large hole and the inner position for the operations on the middle and small holes. The tailstock is moved by a toggle lever motion that is self-locking in both positions. The tailstock spindle runs on ball bearings mounted in a feed sleeve that is actuated through

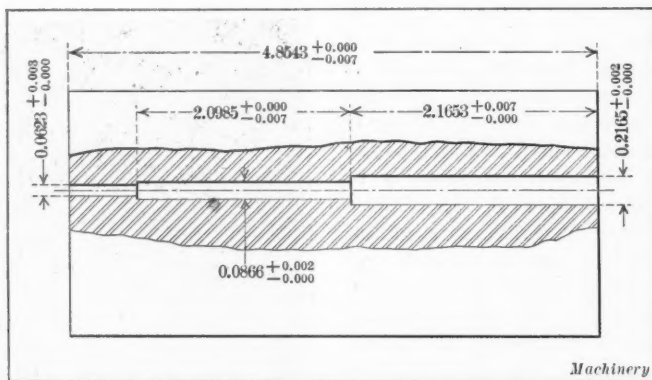


Fig. 39. Gun Part drilled in Machine shown in Fig. 38

so as to permit the operator to open the swing cover, remove the block and put in a blank block. Rotation of the headstock and tailstock spindles is stopped by throwing the friction drive plates on the countershaft out of contact. This is done by the operator by a foot-pedal and long link connection. To bring the headstock spindle to a quick stop, toggle joint shoe brakes that act on a pulley on the jackshaft are automatically put into action when the guard is opened and released when it is shut. To the front end of the inner bearing of the headstock, there is screwed a stationary cover which supports the guide bushings required for the tools, and which also acts on a reservoir for forcing the cutting oil to the tools.

* * *

According to figures recently published, about 6,000,000 shells were used in the operations that resulted in the capture of Messines. Reckoning these at the average weight of slightly over 100 pounds, this represents a consumption of about 300,000 tons of steel.

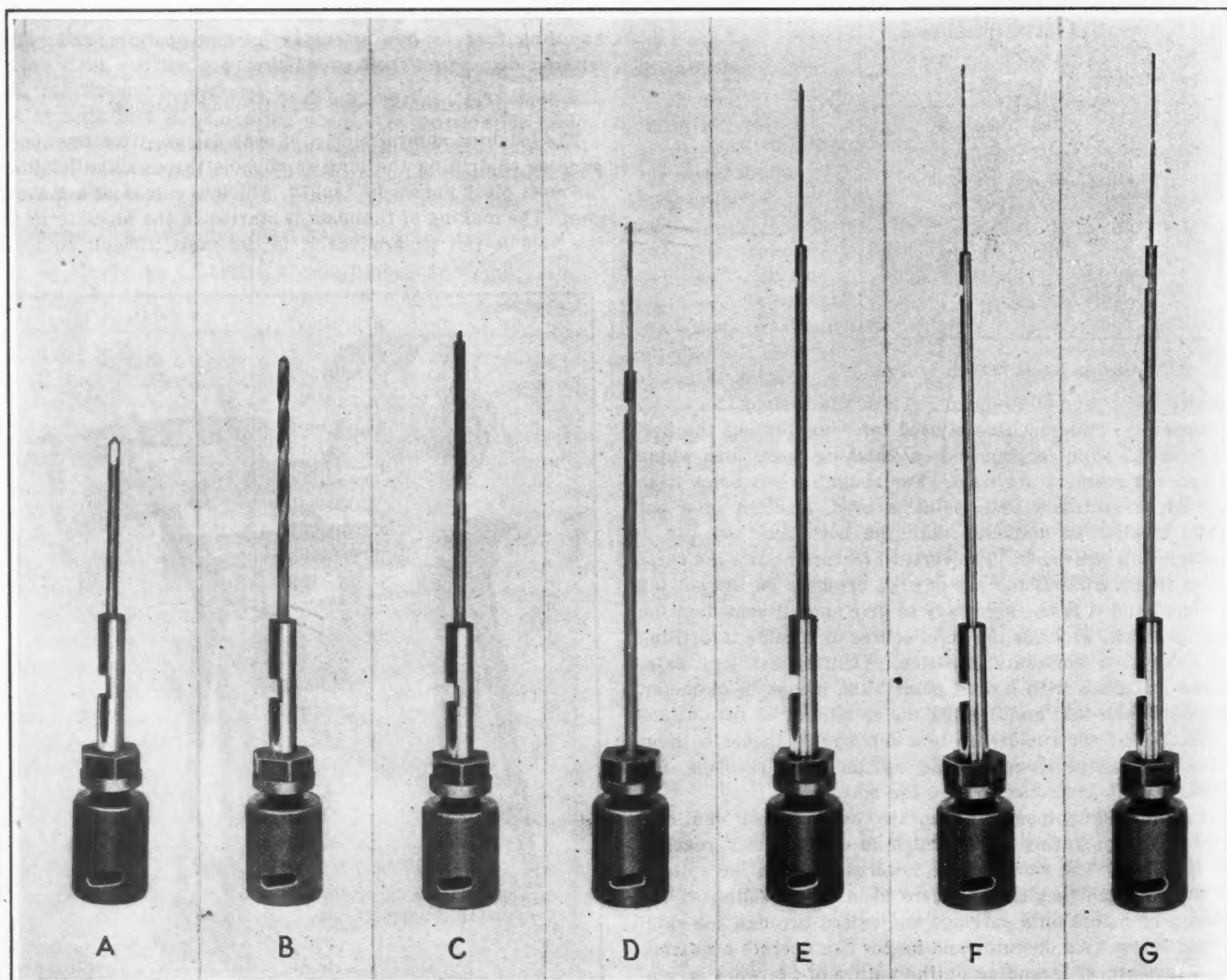


Fig. 40. Tools used in Machine shown in Fig. 38 to produce Hole in Part shown in Fig. 39

INCREASED EMPLOYMENT OF WOMEN IN THE INDUSTRIES

A REVIEW OF THE PROBLEMS INVOLVED IN THE SUBSTITUTION OF WOMEN WORKERS
TO MEET THE PRESENT LABOR SCARCITY

DURING the present year probably not less than a million men, most of them formerly engaged in gainful occupations, have become a part of the armed forces of the United States. Many others have left their regular occupations and are more or less indirectly in the war in munition factories, in shipbuilding and repair plants, and in other industries necessary for the conduct of the war. It is not known how many more men will eventually be called into the Army and Navy, or how many may be required in the manufacture of ships, munitions and other war materials, but it is not likely that this number will be small. The result is a labor scarcity, with indications of worse conditions.

Investigation Made by Merchants' Association of New York

The following paragraphs consist of an abstract of a report prepared by the Industrial Bureau of the Merchants Association of New York, by Alfred L. Smith, manager of the bureau, which is based upon an investigation of present conditions and relates to the present substitution of women in the industries and the methods now in vogue, rather than to the possible extent of their substitution in case the industrial situation becomes more critical. The report summarizes the opinions of employers who have made such substitution, so that other employers interested in the possibility of increasing their labor force in this manner may obtain a comprehensive idea of what has already been done and the chief problems which have arisen. The report is based upon correspondence and interviews with a number of employers who have substituted women workers for men extensively, upon data received from manufacturers' associations, upon reports of investigators who have studied the conditions in various factories, and upon information obtained from 160 replies to a series of questions sent to large employers of labor.

The investigation on the substitution of women for men workers in the industries was made with the idea of answering five questions, as follows:

1. To what extent are women being substituted for men workers at the present time?
2. To what extent do employers expect that such substitution will be necessary in the future?
3. In general, on what types of work, not now ordinarily performed by women, are they satisfactory?
4. Are the wages paid women the same as those paid men in the same or similar positions, provided production is the same in both quantity and quality?
5. What problems, if any, arise from the employment of women in positions ordinarily filled by men?

Extent to which Women Have Been Substituted for Men

Careful investigations have failed to reveal that there has yet been a substitution of women workers on a large scale. For instance, of 160 employers who reported concerning the substitution of women workers in their factories, only thirty-five are as yet using women workers more extensively than formerly. Of these, only nine have substituted any large number of women in positions formerly filled by men exclusively; fifteen, while using women more extensively than in the past, are doing so only in positions which have always been filled by women to some extent; and the remaining eleven are substituting women to only a slight extent.

Probability of Increased Substitution of Women During Period of War

Employers do not agree upon the extent to which women will have to be substituted. Many employers are making plans to substitute more women employees and to fill future increases in their labor force as much as possible through the employment of women. Others, who have not yet employed women, report that they see no other course open to them if conditions become much worse. On the other hand, many employers do not expect to hire any women, in some cases because they expect that the required number of men can be obtained, and in other cases because they feel that women are

unsuitable for their particular work. The indications are, however, that during the next year there will be a rapidly increasing tendency to employ women.

Type of Work Satisfactorily Performed by Women

In addition to the many occupations in which women have customarily engaged, as well as those occupations taken up by them in recent years with success, they are today entering a surprisingly great variety of new occupations, on account of the situation caused by the war. Nevertheless, the type of occupation in which women can give satisfaction is rather definitely limited. In general, the woman worker is either excluded from or at a disadvantage in occupations requiring strength, endurance, control over others—particularly men—willingness to work under particularly disagreeable conditions, long period of apprenticeship, and natural mechanical ability. It is generally considered impracticable to employ women where it is necessary to lift heavy weights.

On the other hand, the female worker has advantages in many occupations usually considered distinctly male. On all kinds of light work requiring manual dexterity, quickness of hand, eye or brain, which can be accomplished after a comparatively short period of instruction, a woman generally learns more quickly than a man, and eventually turns out more and better work.

Obviously, women cannot be substituted for skilled mechanics; neither has the average woman the natural mechanical ability of the man, so that operations of a mechanical nature which a man easily performs, women often find difficult. Women are also likely to prove unsatisfactory, or at least not as satisfactory as men, on mechanical work where tools or machine parts have to be changed frequently. Nevertheless, they are performing satisfactorily a great many of the operations ordinarily performed by skilled mechanics. One manufacturer states: "We have found in our short experience that women can be taught to perform quite a number of the operations of our work so long as the work is not heavy, but they can only perform the operations that have been taught them. They, of course, have to be taught these various operations, because they are not skilled mechanics. Skilled mechanics do not have to be taught how to perform these operations, because they learn to do all kinds of mechanical work when they serve their time, and all they need is to be given the machines with which to do the work and the blueprint to show them what is required."

Employers have stated that women substitutes have proved to be superior to the men whose places they have taken in picking and sorting materials, in operating automatic machinery, in light assembling, in winding coils, as drill hands, and as inspectors. They are proving successful as operators of lathes and similar machine tools, machinery oilers and cleaners, timekeepers, and inspectors. Undoubtedly, they are filling many other occupations satisfactorily, but these give an idea of the kind of employment which is evidently most suited to women.

In Great Britain, France and Italy, women form a very important element in many occupations in which there has yet been no need for them in this country. In European countries women have been used in any position they can fill at all, rather than in only those positions which they can fill as well as men. This has resulted in radical changes in machine operation and factory management, and often in long, careful and especially adapted training for women in industrial occupations.

Wages Usually Paid to Women

One of the perplexing problems of the manufacturer substituting women employees is that of proper wages. Should a woman be paid the same wages as the man whose place she is filling? In theory, there seems to be a unanimity of

opinion that if women can fill a position they are entitled to the usual wage for that position. Nearly all employers who report that they are substituting women, also report that the same wages are paid women as were formerly paid men. The committee on standards of working conditions of the Detroit Executives' Club recommended in a report that women be given equal pay for equal work; and that while learning they be paid the day rate paid men for the same work or operation.

Reasons Given for Paying Women Less than Men

Some concerns pay women less than men, irrespective of the fact that the woman may accomplish as much as the man. In some instances, this is because the employers consider that, because the average man is married and has greater expenses than the average woman, he should rightly receive larger earnings. Others claim that wages for women should be determined entirely by the law of supply and demand; and that, therefore, if the supply of female labor is so large that women will accept lower wages, a lower wage should be paid.

One important employer does not believe that it is right to argue that a higher wage should be fixed for men because they have a family to support, whereas the majority of women have only themselves to support. He states: "The hesitancy of the average honest employer in paying a woman exactly the same rate as a man is on account of not knowing what the future may bring forth, and he, therefore, prefers to start women at a somewhat lower rate than men in order that he may experiment on their relative value. As time goes on, however, it is reasonable to assume that the difference in the wage rate between a man and a woman doing the same work will be comparatively little." This same employer thinks that the wages for women in "war industries" may rightly be determined in a different manner than in factories producing standard products. In a manufacturing plant used exclusively for the manufacture of war materials during the war time, the wage rate for men and women should be the same, if they do exactly the same work and can produce equal amounts, and the finished product is as good in one case as in the other. There seems to be no reason for any difference in the rates, as the manufacture of such products will be discontinued after the war, and the considerations that must be given to the question of permanent employment need not be entered into as thoroughly as in the cases where the manufacturer is producing a standard line of commercial goods that will be continued after the war is over, where consideration must be given to competition with other manufacturers in the United States and foreign countries.

Difficulty of Determining Relative Efficiency

Granting that women are entitled to the same wages as men if they do the same work, there remains the practical problem of determining whether or not the woman employee does turn out equal work. This is a problem for each factory, and even for each type of work upon which women are being substituted. In order to produce equal work, a woman must not only produce as much, but she must maintain quality, and do this with the same cost to the employer per unit of product for supervision, machine operation, helpers and overhead. In cases where the women substitutes are paid by the piece at the usual rate, real wages are actually higher, from the standpoint of the employer, if the women do not turn out the average number of pieces per day, for the reason that more employees are then necessary to maintain production, thereby necessitating more machinery, more supervision, more manufacturing space and more overhead expense.

It is in many cases impossible, or at least very difficult, to determine what should be the piece rate for substituted female labor in factories, if it is attempted to make the labor cost per unit of product the same for work done by women as for that done by men. On operations for which women are well adapted, labor costs may be lower; but on many operations in which women require more time, extra machine appliances and extra helpers, produce a poorer article or spoil more work, they will prove to be more expensive than men. In factories where bonus payments are made for certain tasks accomplished, the difference in cost of female labor is sometimes

more or less accurately offset by a lower bonus rate, although the wage rate is maintained.

Difference in Value of Men and Women Workers

Some employers treat women and men employees as entirely distinct in the matter of wage payments, and the wage schedules are determined as entirely independent of each other. One large employer of both men and women reports as follows:

We have always considered the two groups, male and female, as distinct. The doctrine of "equal pay for equal work" does not apply. There are inherent differences between male and female workers which affect their value to industry and which must be taken into consideration in connection with the question of equal wages. Among the many differences are: (1) The field of work is much larger for men than for women. (2) The average life in industry for men is many times longer than for women. (3) Steadiness is considered greater for men than for women. (4) The attitude toward the work is different.

Another large employer gives a similar idea, as follows:

In establishing rates of pay to women employees consideration must necessarily be given to the particular work which they are to do, because in the employment of an unskilled boy or man, or in the employment of a so-called handy man, the average manufacturer, while expecting to spend considerable money in training men to do a given job, does so in anticipation of the employee's remaining permanently and continuing to learn other operations or details from observation while employed on the less important work, and as time goes on he can be advanced to the more important work without much waste of time or loss of material; while in the case of the employment of women, an employer will naturally assume that the work on which a woman can be employed is limited, and she, therefore, does not become an asset in the same way as in the employment of boys and men. The average woman is also liable to marry and leave.

A third employer writes:

In fact, in every case men and women should be paid, in so far as it is possible to do so, according to a number of different factors; length of service, ability to perform various different tasks desired by the employer; quantity of product produced upon the individual employment; and quality of product. Our records prove that sickness claims on the part of a woman are much greater than those of men, and that their relative absences from employment are greater.

Problems Arising from the Substitution of Women

Employers report many problems arising from the substitution of female labor. The substitution frequently requires many changes, such as shorter hours, rest-room facilities, a welfare superintendent, seats at machines, and luncheon room with facilities for heating food, making coffee, etc. Often radical changes in factory organization and revolutionary changes in production methods are required. The causes of problems reported most frequently by employers in this investigation are as follows:

1. Laws regulating the hours, time and conditions of labor. These prevent women from working under the ordinary conditions existing in many plants.
2. The greater liability of women for accidents due to style of dress, as well as to physical causes. Frequently women are required to wear sleeve holders, and caps to cover the hair. Additional safety appliances must be installed on machines. This is of prime importance if female labor is to be satisfactory, as one accident might affect the morale of all the female machine operators.
3. The necessity of further specialization of labor, particularly where women operate machines. Women are machine operators and not mechanics, and therefore special occupations need to be created for men as helpers, machine repairers and adjusters. In some cases the usual operations are divided and women do the lightest part of a process formerly entirely performed by men, and to the men is left only the heavier part of the operation.
4. The necessity for special machinery or machine parts adapted to operation by women.
5. The necessity for substituting mechanical appliances, as conveying machinery, to minimize physical exertion.

Handling of Women Workers

Some employers find women employees much more difficult to handle than men. They say that they are likely to be more excitable, especially in positions to which they are unaccustomed; and it is claimed that they are often more unreasonable. One employer states that they are greater agitators.

Friction is likely to result in cases where women come into contact with men as co-workers, and particularly when they are in any way in authority over men or boys. Women workers are likely to regard their employment as temporary and, therefore, often lack the same degree of seriousness and earnestness toward their work that men ordinarily have. On the other hand, several large employers report exactly the opposite to be true. Women substituted for unskilled male labor of the lowest grade are likely to be of a better type than the men formerly occupying the positions.

Specific Recommendations for Working Conditions

Employers who are confronted with the problem of substituting female labor will find the recommendations of the committee on standards of working conditions of the Detroit Executives' Club of value. This committee recommends the following working conditions as essential: Separate entrances to be provided for women if practicable; if not, that women be allowed to report for work fifteen minutes later than men and leave fifteen minutes earlier. That separate workshops be provided if possible; if not, that there be both a man and a woman supervisor stationed in the mixed departments. That rest rooms and toilets adjoining workshops be provided with a matron in charge. That a sufficient number of drinking fountains be installed in each department. That the period for lunch be at least forty-five minutes. That, if possible, a restaurant be operated on the premises; if not, at least a counter should be maintained where a box-lunch with hot coffee and tea and milk can be purchased at cost. That provision be made for rest periods during working hours, their frequency and duration depending on the nature of the work. That seats be provided wherever possible to avoid injury to women by standing all day at their work. That sickness insurance be provided to care for workers absent because of sickness. That workers on monotonous and tedious operations, to avoid undue fatigue, be transferred from time to time as seems advisable. That there shall be provision for first-aid attention to all workers. That there be first-class supervision of working conditions, with particular reference to safety, sanitation, ventilation and lighting. That some person be delegated to act as "welfare supervisor" for the plant, to whom women shall have access and whose duty it shall be to have a general oversight over welfare conditions. This position might be given to some woman already in the employ of the company, in addition to her other duties, but, if possible, a trained person should be secured for this work.

Supply of Female Labor

A discussion of this kind is usually thought to presuppose the existence of a great reservoir of female labor which can at any time be called upon. Large employers of women have reported, however, that there has recently been no great surplus of female labor; and, in fact, it is becoming difficult to obtain women workers. The manufacturer who substitutes female labor for male will undoubtedly obtain most of his new workers from other factories rather than from a surplus reservoir of unemployed women; and this condition is likely to continue unless a great many more men are called into the Army and Navy or into the war industries than is expected from present indications, in which case, both economic conditions and patriotism will cause women to enter industry as they have in European countries.

If the supply of male labor further decreases, employers will have to solve more than the problem of properly adjusting the labor conditions, so that women can be employed efficiently. The necessary supply of female labor must first be found, and preferably be found so that women and girls will not be taken from other gainful occupations where they are already of great importance to the welfare of the country in this time of need; otherwise the introduction of women into positions usually occupied by men in industry is likely to result in almost as much harm to industries already employing women as in benefit to industries introducing women into employment. All these problems will have to be carefully weighed, and a solution arrived at, because few employers will be in a position to entirely sidestep this issue.

INSPECTION OF BRONZE AND BRASS¹

In brass and bronze castings, the defect that most commonly occurs is caused by the inclusion of oxide in the metal of the casting. As the admixture of oxide is indicated most distinctly by the greatly reduced elongation and the lowered ultimate strength, the tensile test should be specified for all important brass and bronze castings no matter whether a certain strength and elongation are of mechanical value or not. If a tensile test is impracticable, oxidation in the metal may be discovered by bending a machined specimen; small cracks opening on the outside of the bend indicate the presence of oxide; if the oxidation is extreme, it is shown by the abnormal color of the surface of the fracture. In foundries where tensile or hydrostatic tests are not made, the metal is generally allowed to become considerably oxidized in the crucible, because this defect does not show on the surface of the casting. To specify bronze castings merely by the mixture is therefore useless.

The presence of included dross is more difficult to discover. If a hydrostatic test cannot be made, it is practically impossible to find such defects, unless they happen to come to the surface of the casting; even a hydrostatic test does not always reveal such defects, because there may be considerable thickness of good metal along one or both of the surfaces of the casting. The best insurance against this kind of defects is correct molding. Minor leaks in hydraulic casting may be stopped by peening, but the fact that the casting leaked at a certain point generally indicates that the metal was defective. It is commonly believed that certain brass and bronze mixtures are normally porous and permit water to pass through them under high pressure. This belief is erroneous, at least up to a pressure of 1000 pounds per square inch. If water passes through the walls of a casting, even in minute quantities under smaller pressures, the metal is not clean or the casting is porous from some other accidental condition.

The presence of initial stress in wrought brass may be detected most quickly by cutting a longitudinal slit in the end of the piece. If the initial stress is of sufficient magnitude to be objectionable, the two halves of the piece will curve outward sufficiently to be detected by an ordinary micrometer; and if the stress is great, the curvature may even be visible. Extruded brass rods sometimes contain piping. The presence of this defect may be discovered by nicking the end of a rod and breaking it off.

Another source of defects in brass work is caused by overheating by men unfamiliar with the properties of brass. This overheating produces an interior oxidation, thus greatly reducing the strength of the material and the ductility. Defects of this kind are likely to be very troublesome, because they are difficult to discover by surface inspection and tests cannot be made on finished material.

* * *

Geared turbines were developed mainly for use on board ship in order to reduce the high speed at which a steam turbine will work economically to the speed at which the propeller is most efficient. Recently, however, geared turbines have been applied also for stationary purposes, an example being the installation made in the Northwestern Consolidated Milling Co., Minneapolis, Minn., where a 1700-horsepower Westinghouse high-pressure condensing turbine operating at 3000 revolutions per minute is geared to a flour-mill shaft operating at 140 revolutions per minute, single reduction gearing being used, the reduction being approximately 21 to 1. It is estimated that the efficiency of this gearing is 98 per cent, and as the load is practically constant, a geared turbine drive is more efficient than an electrical arrangement with generators and motors would be. Another advantage in favor of the geared drive is that it occupies a very small space. In this particular case, the turbine and gearing are installed in practically the floor space occupied by the driving pulley alone of the reciprocating engine which was formerly used. The old engine required altogether four times the floor space that the new installation occupies.

¹Abstract of a paper read by Ernst Jonson before the American Institute of Metals in Cleveland, Ohio, September, 1916

AUTOMATIC CONTROL AND MEASUREMENT OF HIGH TEMPERATURES¹IMPROVEMENTS IN SENSITIVENESS AND RELIABILITY OF MEASURING INSTRUMENTS
AND IN CONTROL DEVICES

PROBABLY no employe has caused the average works manager more sleepless nights than the furnace man, on whom rests the responsibility for the uniformity of the product. Through years of practice, an old furnace man is able to judge the temperature fairly accurately; but we can pardon the works manager for thinking, "Suppose John dies, gets sick, or quits." For this reason much study has been given to both the perfection of pyrometers and the automatic control of temperature. It has, however, been only recently that real results have been accomplished in automatic temperature control.

First of all, it was necessary to perfect the temperature-measuring instruments, so that they could be relied on to indicate uniformly the actual furnace temperature. It was then necessary to apply to the pyrometers attachments that would throw the switches on the electric furnaces, or open or close the valves on gas or oil furnaces. For industrial service, an instrument actuated by the expansion of nitrogen gas is the most satisfactory for temperature measurements up to 800 degrees F. or 425 degrees C. The gas is in a bulb of copper, which is inserted in the heat and is connected, by capillary tubing, to an indicating or recording gage containing a helical expansive spring. The expansion of the gas exerts a pressure in the capillary tubing which is conveyed to the spring in the instrument, and the pointer attached directly to this spring moves across the scale or chart. The capacity of the bulb must be fifty times as great as the capacity of the capillary tubing and springs, so as to reduce to a minimum

errors due to atmospheric changes in temperature along the capillary tubing or at the instrument. In consequence, this instrument is not desirable for use where the gage must be placed more than 100 feet from the bulb.

For use at moderate temperatures where the measuring instrument must be placed at a considerable distance and for temperatures above the range of the gas-expansion instrument, the thermo-electric pyrometer has been almost universally adopted in the United States. A thermo-couple of base metals, usually formed of one wire that is 90 per cent nickel and 10 per cent chromium and a wire that is 98 per cent nickel and 2 per cent aluminum, is preferred for temperatures up to 1800 degrees F. or 1000 degrees C. For temperatures above this, and as high as 2800 degrees F. or 1500 degrees C., thermo-electric pyrometers using a platinum-rhodium thermo-couple are the most satisfactory. For higher temperatures still, a radiation type of pyrometer is available. This consists of a thermo-couple in the focus of a reflector at the rear end of a tube that is pointed at the door or opening of the furnace.

For measuring the voltage produced by a thermo-couple, whether of base metal, platinum-rhodium, or the radiation type, millivoltmeters of 1000 ohms resistance are available. This high resistance is desirable to practically eliminate the errors due to changes in the resistance of the line or wiring connecting the thermo-couples and the instrument, and also to nullify the effects of any changes in the resistance of the thermo-couples due to heating. Changes in resistance may be due to actual changes in length or changes in atmospheric temperature, which, in turn, affect the resistance of the line

or wiring. This high resistance has been secured by reducing the weight of the moving element to a minimum.

In one case the total weight of the moving element, including pointer and springs, is 526 milligrams. This extreme lightness is secured by the use of an enameled aluminum alloy wire. As the enamel coating is much thinner than the silk insulation formerly used, more turns can be secured on a coil of a given width. Likewise the weight has been reduced 66 2/3 per cent as compared with copper wire, which was formerly used for these moving elements. The aluminum wire is 0.003 inch in diameter and its drawing has been quite a mechanical problem. The aluminum pointer tubing has an inside diameter of 0.008 inch and an outside diameter of 0.012 inch, or a total thickness for the wall of the tubing of 0.002 inch. Probably the weight of the tubing could be reduced by using magnesium, but so far magnesium has not been satisfactorily drawn.

It will be understood that the electrical system described

can be used either to indicate or record the temperature. By the introduction of suitable switching mechanism, a record of the temperature of quite a number of thermo-couples can be made on the same record sheet. These temperature records are distinguished by the use of different colors for each record line, using numbers corresponding to each thermo-couple, or changing the form of line produced on the chart for identification.

Brown Heatmeter

For greater precision in temperature measurements than is secured with the high-

resistance millivoltmeter, the Brown heatmeter, shown in Fig. 1, has been developed. This instrument is suitable for either temperature measurement or automatic control of temperature. The idea in its development has been the elimination of all the bad features or drawbacks found in using a millivoltmeter for temperature measurement.

Among the possible sources of error in the use of a millivoltmeter (even one of high resistance) are changes in the resistance of the circuit comprising the thermo-couple and the leads or wiring, due to changes in length or atmospheric changes in temperature. Errors can also be caused by atmospheric changes in the temperature of the meter itself and by changes in the actual indication of the instrument, due to spring fatigue, abuse or sticking.

Briefly, the operation of the heatmeter is as follows: With the standard high-resistance millivoltmeter there are furnished an ordinary dry cell about 1 1/4 inch in diameter by 2 1/2 inches long, and rheostats to reduce the voltage of the dry cell to a range of 0 to 60 millivolts, the maximum voltage produced by the thermo-couples. First, the voltage developed by the thermo-couple is opposed to the reduced voltage of the dry cell; when the pointer stands on zero, the voltage from each source is equal. Second, the voltage of the thermo-couple is cut out and the voltage of the dry-cell circuit is read by direct deflection. This eliminates the line resistance entirely, as in a potentiometer, and indicates the actual temperature developed by the thermo-couple at the moment of reading the instrument, but fluctuations in temperature of the thermo-couple will not be indicated, as the voltage from the dry cell is being read. Third, the thermo-couple is connected to the meter instead of the dry-cell circuit to see if the indications are the same.



Fig. 1. Brown Precision Heatmeter

¹Abstract of a paper prepared by Richard P. Brown, of The Brown Instrument Co., of Philadelphia, Pa., and read before the Faraday Society, of London, England, November, 1917.

By switching back and forth quickly, the voltage from the thermo-couple circuit or from the dry-cell circuit can be noted. If excessive line resistance has caused the indications of the millivoltmeter to be lowered, as compared with the dry-cell circuit, a rheostat is operated to bring up the indications of the thermo-couple circuit to that shown when the voltage of the dry-cell circuit was read. Leaving the instrument indicating on the thermo-couple circuit eliminates the errors that might be due to line resistance or changes in temperature of the line, and a direct-reading millivoltmeter indicating the correct temperatures is obtained.

The temperature coefficient of the meter has been eliminated by furnishing a copper resistor in the meter equivalent to the copper or aluminum of the coil; hence in balancing the voltage from the dry cell against that of the thermo-couple errors due to the temperature coefficient of the meter itself are automatically eliminated. To obviate errors due to sticking of the pointer, abuse of the instrument, spring fatigue, etc., the instrument, when desired, is supplied with a standard cell with suitable resistors and can be checked in the same manner as the meter can be tested by the potentiometer method. Where the instrument is supplied with a standard cell, the temperature of the instrument should always be between 5 and 40 degrees C. or 40 and 105 degrees F. In fact, any standard cells used in instruments will be injured if the temperature rises or falls beyond these limits.

Automatic Temperature Control

Attempts have been made to operate switches and valves electrically by permitting the pointer of the pyrometer to come in contact with adjustable contact arms on each side of the pointer. Unfortunately, the millivoltmeter used with the thermo-electric pyrometer has an exceedingly weak control for the pointer; in fact, the pointer may be easily blown across the scale. In consequence, simply permitting the pointer of such a pyrometer to move into contact is not sufficiently positive to be satisfactory for automatic control work.

An automatic-control pyrometer recently developed, shown in Fig. 2, operates in the following manner: A thermo-couple, formed of a nickel-chromium alloy, is installed in the electric furnace, the temperature of which is being controlled, and actuates a high-resistance millivoltmeter. Below the pointer, and adjustable throughout the whole scale range, is a table carrying two contact pieces that are separated by a piece of insulating material 1/32 inch thick. The depressor arm, which is driven by a small electric motor, or by a clock if preferred, depresses the pointer at regular intervals, usually every ten seconds, causing the two contact pieces to be forced together.

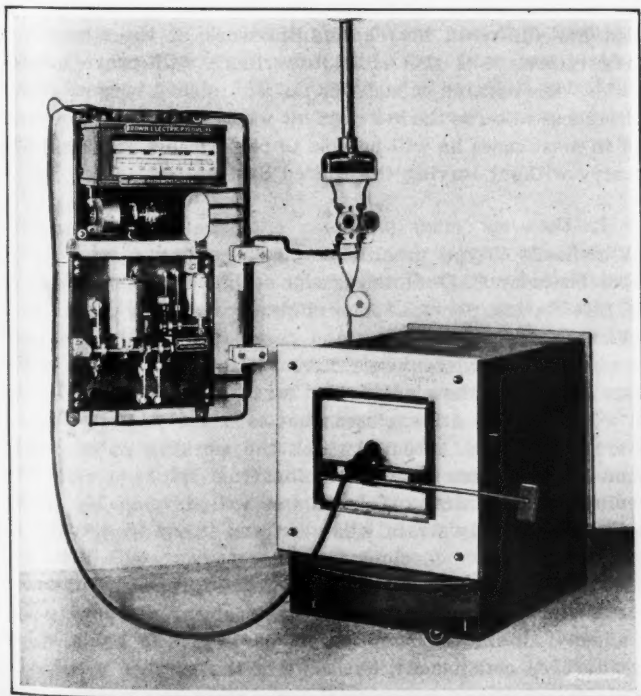


Fig. 2. Automatic Control Instrument attached to Electric Furnace

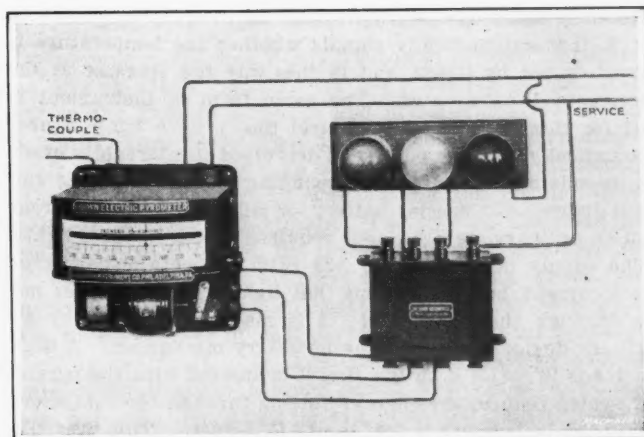


Fig. 3. Automatic Signaling Lighting Equipment

Assume that it is desired to maintain a temperature of exactly 1400 degrees F. The knob on the left of the instrument is turned until the index in front of the scale stands at 1400 degrees F., at which the thin insulating material will then separate the high and low contacts. The switch connecting the furnace in the line is closed and the pointer slowly rises across the scale as the temperature of the furnace rises. As the switch is already closed, when the pointer is depressed on the low contact the switch remains closed and no change occurs until the pointer passes over the insulating piece, when a switch, indirectly operated by a solenoid and relay, is instantly actuated and the circuit is opened. The temperature of the furnace then falls until the pointer is again depressed on the low contact and the circuit is again closed. This operation continues as long as the furnace is to be operated.

When the switch opens or closes the main circuit, the current is either full on or full off, and the fluctuations are continuous within narrow limits of 10 to 20 degrees F. This continuous rising and falling of temperature can be largely reduced and closer control can be procured by the use of two rheostats in the furnace line. The solenoid-operated automatic switch is then used simply to cut in and out of circuit the second rheostat. Assuming that it is desirable to maintain 1400 degrees F. in the electric furnace, irrespective of fluctuations of voltage, the two rheostats are set so that with only one in the circuit the temperature will rise to approximately 1500 degrees F; with the second rheostat in the circuit the temperature drops to 1300 degrees F. When the solenoid-operated switch is used to cut in and out the second rheostat, the temperature is controlled only between 1500 and 1300 degrees F., and there are no rapid surges in temperature, maximum control being secured.

The same form of switch can be used to operate a valve to control a gas or an oil furnace. It has been found desirable to use an automatic valve in a by-pass to control part of the gas or oil supply, for this plan eliminates the maximum fluctuations caused by the complete opening and closing of the switch or valve. For instance, if a 2-inch pipe supplies the gas to the furnace, it is customary to by-pass this and use a 1/2-inch automatic valve, which gives approximately 25 per cent control. This is sufficient to control the usual fluctuations in gas supply and secure satisfactory control.

Temperature Signaling Pyrometer

In addition to an instrument to control furnace temperatures automatically, there has been a demand for an instrument to signal by lights whether the temperature is too high, correct, or too low in any particular furnace. It has been common practice for plants having a number of heat-treating furnaces to maintain an operator at a central pyrometer, and by colored electric lights at the furnace to signal whether the temperatures are right or not. Usually, three lights are placed above each furnace, red, white and green; the red light burns when the temperature is too low, the white light when the temperature is within certain limits, for example, 20 degrees F. of the correct temperature, and the green light when the temperature is too high. The fireman who operates the furnace is guided entirely by the lights.

Recently there has been developed an instrument, shown in Fig. 3, that automatically signals whether the temperature is correct or not by lights, and in this way the operator at the instrument is eliminated. The same form of instrument is used for this purpose as to control the furnace temperatures automatically, and the pointer is depressed at intervals of every ten seconds onto contacts corresponding to the red, white and green lights. No special battery or other source of current than an ordinary service line is required to operate these lights.

The supply may be 110 or 220 volts, either alternating or direct current, but the current that lights the lamps does not flow through the instrument; it is made and broken by an auxiliary device containing the necessary mechanism. A high resistor is in series with the circuit connected with the pyrometer, which reduces the current flowing through the contactors within the instrument to less than 0.07 ampere. This prevents sparking at the contactors and errors due to the heating effect of a current of higher amperage. The lamps may be any reasonable distance from the pyrometer; in fact, they are operative at a mile or more if desired. The various thermocouples in each furnace are connected successively to the instrument through switching mechanism, and at the same time a switching mechanism connects the various sets of lights at each furnace. There has been constructed an instrument of this type to take care of the signal lights at twelve furnaces.

This form of equipment gives the fireman or operator of the furnace an indication by lights that he can easily understand, and he adjusts the valves or fires the furnaces accordingly. It is a simple method to instruct a man to keep the white lights burning and to explain what the red and green lights mean, and a less experienced workman is required to control the furnaces in this manner than where it is necessary to read temperatures on a pyrometer scale.

The extensive use of pyrometers to measure or record high temperatures will serve to eliminate guesswork as to the temperature; reduce fuel consumption, through the maintenance of the correct temperature and not excessively high temperatures; reduce time for heating the product, due to the maintenance of the correct temperature; and increase the efficiency in operating a plant. Instruments to control the temperature automatically, when properly constructed and applied, will eliminate the personal element entirely. The maintenance of the correct temperature in the furnace is automatic, and this is one step further, and, in consequence, an improvement over temperature control through pyrometers. The next few years will see further improvements in pyrometers and temperature control. There will always be room for improvement, and the cooperation of the industrial works and the pyrometer manufacturers will hasten the development of practical instruments for the measurement and control of high temperatures.

* * *

UNITED STATES PUBLIC SERVICE RESERVE

A special bureau organized under the direction of the Department of Labor, known as the United States Public Service Reserve, has been created to obtain information relating to the labor resources of the country available for various classes of work required in connection with the war. The object of the Public Service Reserve is to provide an agency where all men who are willing to work at their own trade to help win the war may place themselves on record, notifying the bureau of their readiness to serve and of their capacity for service. This record, when once placed on file, will be available to all branches of the government concerned with the war. It is especially intended for men who are willing and ready, when the call comes, to give up jobs which are not vitally important in war times to take up work in which the country needs them. Men who list themselves with the Public Service Reserve are carefully indexed according to their qualifications, so that they may be located at once when men of their skill or ability are needed. They are then promptly notified that they are required for undertaking work in a civilian capacity, either for the government or for employers working on government war contracts.

Men of draft age who are likely to be called soon are not wanted in the Public Service Reserve. It is intended mainly for the men who do not expect to do military service. Enrollment in the Reserve is no ground for exemption from military duties. However, it gives to the man who wants to serve his country the assurance that when he has enlisted in the Reserve he has done his full present duty, and he can continue to work at his present task with a good conscience until called upon to serve his country elsewhere.

The Public Service Reserve is needed because millions of Americans must engage in industries essential to the war if the war is to be won and won quickly. An ever-increasing number of men will be needed for building ships and airplanes, for making munitions and equipment for the Army and Navy, and for other purposes in connection with the war. In order that these men may be called quickly when needed, the government must know in advance who are available and where they are, and must have a great volunteer reserve of men who stand ready to work for good wages under reasonable conditions in the industries essential to war.

All classes of men are requested to join the Public Service Reserve, if they are in a position to change to such work as may be designated when required to do so. Professional men, engineers, machinists, toolmakers and all other classes of skilled mechanics are required. In fact, every man who wishes to serve is asked to register, no matter what his qualifications; but only men who are really ready and able to respond when the opportunity for service requires them should enroll. The files of the Reserve must not be swamped with records of men who are merely expressing patriotism, but who, when the call comes, would not be able to respond immediately.

Most of the positions offered will be well compensated. No obligation exists to respond to a call when it comes, but it is, of course, expected that most of those who have joined will know in advance that they will be able to take up whatever work is required of them. Should they, however, be prevented from doing so by unforeseen circumstances, they have a full right not to respond to the call. Hence, enrolling in the Reserve places only a moral, but no legal, obligation upon the man who so joins. Applications for membership may be obtained from the Department of Labor, United States Public Service Reserve, 1712 I St., Washington, D. C.

It should be particularly pointed out in this connection that in asking a man of engineering or mechanical experience to enroll in the Public Service Reserve, a rare combination of opportunities are open to him which are not open to the average patriotic American. The engineer or mechanical man can serve the country in his most effective capacity and at the same time keep in touch with his own profession or trade, with the result that his patriotic service will not have diminished his ability in his chosen life work at the time when peace returns, but the added experience will prove helpful to him. His earning capacity is not diminished because of his willingness to serve the government where he is most required, and in most cases he will be able to perform his service to the country without leaving the United States.

* * *

A twin-six V-type gasoline engine has been designed for motor boats by C. D. Holmes, who designed a motor used by the Life Saving Service. The engine weighs 3400 pounds, is eight feet, four inches long and three feet, ten inches high. Its especially high crankcase increases the accessibility of the parts as well as the rigidity and strength of the mechanism. All working parts are enclosed; but each part is accessible by covered handholes, through which the working parts can be taken without removing the motor from its base. At 1000 revolutions per minute, this engine will develop 300 horsepower, without any strain whatever, and it can be speeded up to 1400 revolutions, developing 400 horsepower, with little evidence of extra effort. One horsepower is produced for every nine pounds of engine, while the ratio of engines now in use is about 1 to 20. Production of parts of the engines has already been commenced, but none of the engines will be offered for private or commercial use during the period of the war.

IDENTIFICATION MARKS FOR STEEL

Every metal-working concern buys a variety of steel in bars, and many use some means of identifying the various kinds, especially tool steel. A common method is to paint the ends of the bars when received in the store-room, but the serious objection to this is the fact that the identification mark may be lost when the bar is cut up. Workmen are not always careful to remove the desired stock from the same end of the bar, and it often happens that the paint markings are removed from both ends of the bar.

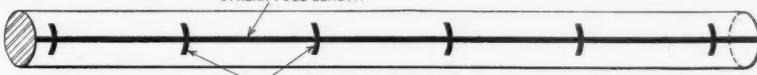
The plan of steel marking shown in the identification chart, used in modified form by the Rockford Drilling Machine Co., Rockford, Ill., was worked out by the superintendent, E. K. Morgan, and it eliminates the trouble of losing the identifying mark when both ends of a bar are cut off. When the steel is received in the store-room, the stock-keeper lays a number of bars side by side on horses, and with a brush paints a streak on each of the bars lengthwise. Then, with the brush bearing the same or another color, he paints marks across the bars at intervals of about three feet. By using red, yellow, green, black, blue and white length marks and the same color cross marks, and no cross marks, forty-two kinds of steel are provided for. It will be noticed in the chart that high-speed steel has a red streak; tool steel, a yellow streak; machine steel, a

THE AMERICANIZATION OF IMMIGRANT LABOR IN OUR INDUSTRIES

On account of the war it has become of greater importance than ever to create facilities for the education of immigrant labor in the English language and in American ideals. Employers in whose works great numbers of foreign-born men or women are employed could do no greater service to the country at the present time than by creating facilities for the Americanization of these immigrants. The city of Cleveland has taken active steps toward the installation of an organized system for the education of non-English-speaking aliens. An Americanization information bureau has been installed which gives to aliens, free of charge, information in all languages regarding the draft, proclamations and regulations affecting aliens, naturalization, Liberty bonds, Red Cross work, and other war measures. The bureau, with the authorization of the draft boards, acts without charge as notary public for all immigrants filing exemption claims and sees that affidavits are properly filled out. War information centers have been established in 350 places throughout the city, which receive regularly from the bureau official information regarding war matters and Americanization. All industrial plants employing more than twenty-five non-English-speaking aliens, that have had their English-speaking force disorganized by the army or

IDENTIFICATION OF DIFFERENT GRADES OF STEEL

STREAK FULL LENGTH



CROSS MARKS EVERY THREE FEET

STREAK	RED	YELLOW	GREEN	BLACK	BLUE	WHITE	NO MARK
BARS	High-speed	Tool Steel	Mach. Steel	Finished Steel	Nickel Steel	Special Steel	Screw Stock
Blue.....	Blue Chip	0.80 Carbon	0.15 Carbon	0.15—0.25 C. Turned and Gr.	3.50 Ni.— 0.15 C.	Low Ni. Chr.— Oil-treated	.....
White	Novo	0.90 Carbon	0.25 Carbon	0.25—0.35 C. Turned and Gr.	.....	.....	.....
Yellow .....	.....	1.00 Carbon	0.35 Carbon	0.35—0.45 C. Turned and Gr.	.....	.....	.....
Green .....	.....	1.10 Carbon	0.45 Carbon	.....	.....	.....	.....
Black.....	.....	1.20 Carbon	.....	.....	.....	.....	.....
Red	Red Cut Superior	Non- Shrinking	.....	Drill Rod	3.50 Ni.— 0.45 C.	.....	Machinery

green streak; and so on. If the stock has no streak, it is some kind of screw stock.

The plan is one that can be used generally by machine shops, and may be applied with many variations. It would be desirable to have it worked out to a near standard form and generally adopted. Then workmen going from one plant to another would know instantly that steel marked lengthwise with red was high-speed; yellow, tool steel; green, machine steel; and so on.

Wood patterns must be protected from moisture of the molding sand or they will swell and warp out of shape. Shellac serves the purpose of excluding moisture satisfactorily when only a few castings are required, but if many are needed, it is customary to use metal patterns, preferably aluminum, because of its lightness. But aluminum now is scarce and high-priced and substitutes are being used. The fact has been recognized that wood patterns may be waterproofed by plating them with copper or aluminum by the Schoop process. The plated pattern is made practically moisture-proof, and in the case of thin sections is considerably strengthened by the thin metal coating. The plated pattern has practically all the advantages of a metal pattern, being smooth, light and strong. There is a limitation to the metal protective coating, however. Large patterns are likely to swell with changes of temperature sufficiently to crack the coating and permit the ingress of moisture, which still more increases the width of the cracks.

navy recruiting and the draft, have been circularized and visited, and plans are pending to train their alien labor, in or near the plants, in English and civics. An Americanization institute to train teachers of immigrant classes was opened, with an attendance of 450 drawn from the alumni of the Western Reserve University, the Normal School, the Training School, and the College Club.

In Detroit similar measures are advocated, and it is certainly highly important, because, if the United States is to win the war, foreign-born men and women must of necessity constitute an important source of the labor supply and must be made entirely dependable and reliable. They must understand the English language and become citizens in order to have a stake in the country and take an interest in it. They need American standards of living for physical efficiency. In the present crisis many of our industries absolutely necessary in the conduct of the war are largely manned by immigrants. Industrial difficulties with these men due to the misunderstandings that arise because they are not Americanized may cause national difficulties of great magnitude. Hence manufacturers in both large and small industrial centers where foreign labor is employed should exert every effort toward making these men good American citizens.

U-boats are now said to be made without periscopes. A lens on each side of the boat is used in conjunction with other lenses and reflectors. With this device, however, the boats must navigate nearer the surface than when periscopes are used.

STRESSES IN TURBINE WHEELS

METHODS AND VALUES BY WHICH STRESSES IN TURBINE WHEELS MAY BE DETERMINED

BY WILLIAM KNIGHT¹

AN accurate analysis of the stresses in a turbine wheel due to the centrifugal forces of the wheel itself and to the centrifugal forces of the blades fitted at the periphery is a rather complicated analytical problem. Formulas for obtaining stresses under these conditions refer to some particular shape of disk, and how the difference between the actual shape and the shape assumed in the calculations will affect the results is left to the designer to estimate and to allow for in his design. This is because a strictly accurate determination of the stresses in a rotating disk of varying thickness, with a hub at the bore and a rim of irregular section at the periphery and carrying blades attached to the rim, is very difficult to obtain.

By assuming that the outline of the disk is a hyperbola and that the effect of the blades is equivalent to their centrifugal force uniformly distributed at the periphery of this disk, it is possible to derive a formula for determining the radial and the tangential stresses produced by the centrifugal force of the disk and the blades at any point between the bore and the periphery. Such a formula gives only an approximate solution of the problem, because it does not take into consideration the variation of the actual shape of the disk from the hyperbolic shape assumed (especially at the periphery and at the hub, where the outline of the disk departs the most from the hyperbola), and yet it is not easily applied. A long and tedious process of calculation involving the probability of making errors is required for solving the formulas, and this must be repeated several times, when designing a disk, before the proportions that will secure the most efficient design can be determined. To save the time required for making these calculations and eliminate the probability of making errors, the accompanying tables have been prepared.

At any point of a rotating disk, there is a radial and a tangential stress produced by the centrifugal forces of the disk and of the blades. The tangential stress at any point, due to the centrifugal force of the disk, added to the tangential force at the same point due to the centrifugal force of the blades, will give the total tangential stress at that point due to the centrifugal force of both the disk and the blades. In the same way, the total radial stress at any point is obtained by adding the radial stresses produced at that point by the centrifugal force of the disk and of the blades. The radial stress produced by the centrifugal force of the disk is zero at the periphery and at the bore, and reaches its maximum value in the middle portion of the disk.

The radial stress produced by the centrifugal force of the blades only, assumed as being uniformly distributed at the periphery of the disk, varies from zero at the bore to a maximum at the periphery. The tangential stress produced by the centrifugal force of the disk, and the tangential stress produced by the centrifugal force of the blades, reach a maximum either at the bore or at the periphery, depending on the shape and the proportions of the disk. For instance, the larger the ratio of the bore diameter to the diameter at the periphery, the more pronounced is the tendency of the stress at the bore to become larger than the tangential stress at the periphery.

A disk of hyperbolic profile is such that the thickness y at any point distant x from the center is equal to:

$$y = \frac{c}{x^a} \quad (1)$$

where a can be positive, negative, or zero. If $a = 0$, $y = c$ for any value of x , which is the case of a disk of uniform thick-

ness. If a is positive, the thickness of the disk is larger at the bore than at the periphery, which is the case with all turbine wheels. Values of a between 0 and 2 cover a wide range of wheel shapes commonly used in turbine design. If a is negative, the thickness of the disk increases from the bore to the periphery, which is a very unusual design.

If the section of a turbine wheel is laid out and it is desired to find the values of c and a that, substituted in Formula (1), will give values of y for various values of x , which will more closely approach the thickness of the wheel at different points, as laid out, Formula (2) may be applied:

$$a = \frac{\log y_1 - \log y_2}{\log x_1 - \log x_2} \quad (2)$$

in which y_1 and y_2 are the thicknesses of the wheel at two points distant x_1 and x_2 from the center. Having found the value of a , $c = y_1 x_1^a = y_2 x_2^a$. Substituting the values of c and a thus found in Formula (1), all the points of a hyperbola that will coincide with the outline of the wheel, at least at x_1 and x_2 , can be found. Then the outline of the wheel can be slightly modified so as to make it follow the hyperbolic profile as far as possible, or a hyperbola that will fit more closely to the outline of the wheel as laid out may be found.

It is well to note that the value chosen for a must be such as to give a hyperbola that will follow, as closely as possible, the profile of the outer portion of the disk. A variation of the hyperbola from the outline of the disk as laid out, in points near the bore, will have only a small influence in the calculation of stresses; but any variation in points near the periphery will have a decided influence in the stresses calculated. Consequently, the addition of metal at the hub will not increase the stress at the bore (which is the point where, in general, the tangential stress is a maximum) and will add strength to the wheel at its weakest point; an addition of metal at the periphery will considerably increase the tangential stress at the bore of the wheel.

Having found the value of a giving a hyperbola that will more closely approach the outline of the wheel, the values of T and R can be obtained from Tables 1 to 5 and Tables 6 to 10, respectively, for values of $a = 0$, $a = 0.5$, $a = 1$, $a = 1.5$ and $a = 2$ and plotted on cross-section paper against different values of a . Joining with a curve the five points thus obtained for T and R , the values of T and R for any intermediate value of a between $a = 0$ and $a = 2$ are easily found. All the tables give numerical values for corresponding values of m and m_0 , where

$$m = \frac{\text{Diameter at any point}}{\text{Outside diameter of disk}}$$

$$m_0 = \frac{\text{Diameter at bore}}{\text{Outside diameter of disk}}$$

The tangential and radial stresses at any point of a rotating disk for any value of a between 0 and 2 may be obtained by plotting five values of T and R for the corresponding values of m and m_0 . The tangential and the radial stresses of the disk only, at any point, as determined by m and m_0 , are:

$$T_t = ST \quad (3)$$

$$T_r = SR \quad (4)$$

where T and R = factors obtained from the tables;

S = tangential stress of a thin ring rotating at same peripheral speed as disk.

For cast iron, $S = 0.0972V^2$ pounds per square inch

For steel, $S = 0.105V^2$ pounds per square inch

where V = peripheral speed of disk, in feet per second.

With the metric system,

For cast iron, $S = 0.0735V^2$ kilograms per square centimeter

For steel, $S = 0.079V^2$ kilograms per square centimeter

where V = peripheral speed of disk, in meters per second.

The tangential and the radial stresses at any point of the disk due to the centrifugal force of the blades and the rim

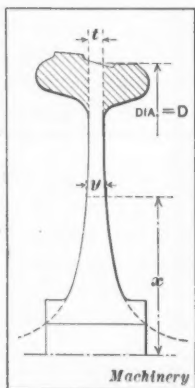


Diagram illustrating Stress in Turbine Wheels

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TABLE 1. VALUES OF T FOR $\alpha = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.815	0.493	0.434	0.408	0.369	0.337	0.304	0.266	0.225	0.181
0.2	0.823	0.584	0.488	0.432	0.385	0.343	0.299	0.254	0.206
0.3	0.830	0.636	0.533	0.461	0.404	0.347	0.299	0.246
0.4	0.841	0.675	0.568	0.490	0.434	0.362	0.303
0.5	0.858	0.706	0.602	0.517	0.444	0.375
0.6	0.876	0.739	0.634	0.545	0.467
0.7	0.897	0.766	0.660	0.570
0.8	0.927	0.803	0.697
0.9	0.959	0.837
1.0	1.000

TABLE 2. VALUES OF T FOR $\alpha = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.500	0.323	0.304	0.299	0.290	0.284	0.255	0.226	0.191	0.145
0.2	0.617	0.445	0.392	0.349	0.320	0.291	0.255	0.217	0.175
0.3	0.706	0.550	0.465	0.418	0.364	0.317	0.270	0.220
0.4	0.763	0.619	0.527	0.450	0.397	0.335	0.270
0.5	0.818	0.682	0.575	0.493	0.425	0.355
0.6	0.853	0.733	0.630	0.550	0.475
0.7	0.905	0.765	0.659	0.570
0.8	0.934	0.811	0.700
0.9	0.963	0.840
1.0	1.000

TABLE 3. VALUES OF T FOR $\alpha = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.295	0.201	0.205	0.216	0.229	0.229	0.207	0.189	0.159	0.120
0.2	0.463	0.349	0.305	0.286	0.271	0.244	0.220	0.187	0.155
0.3	0.584	0.438	0.379	0.346	0.303	0.268	0.231	0.185
0.4	0.680	0.536	0.463	0.399	0.350	0.304	0.250
0.5	0.759	0.620	0.530	0.455	0.395	0.330
0.6	0.819	0.690	0.586	0.512	0.445
0.7	0.739	0.637	0.550	0.475
0.8	0.909	0.788	0.690
0.9	0.950	0.835
1.0	1.000

TABLE 4. VALUES OF T FOR $\alpha = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.174	0.125	0.140	0.158	0.172	0.178	0.173	0.158	0.133	0.101
0.2	0.351	0.255	0.229	0.224	0.216	0.204	0.182	0.157	0.121
0.3	0.490	0.356	0.312	0.284	0.259	0.228	0.196	0.167
0.4	0.610	0.480	0.417	0.363	0.311	0.269	0.223
0.5	0.708	0.584	0.498	0.421	0.367	0.308
0.6	0.792	0.664	0.558	0.489	0.419
0.7	0.860	0.720	0.634	0.545
0.8	0.905	0.775	0.673
0.9	0.950	0.830
1.0	1.000

TABLE 5. VALUES OF T FOR $\alpha = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.070	0.080	0.097	0.118	0.135	0.145	0.149	0.131	0.122	0.082
0.2	0.262	0.192	0.180	0.181	0.180	0.177	0.157	0.148	0.105
0.3	0.414	0.321	0.278	0.256	0.239	0.213	0.191	0.152
0.4	0.550	0.443	0.376	0.336	0.292	0.257	0.203
0.5	0.668	0.550	0.465	0.401	0.353	0.291
0.6	0.760	0.643	0.553	0.478	0.399
0.7	0.850	0.735	0.646	0.545
0.8	0.903	0.785	0.675
0.9	0.950	0.840
1.0	1.000

TABLE 6. VALUES OF R FOR $\alpha = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.294	0.330	0.322	0.294	0.254	0.204	0.145	0.0775	.....
0.2	0.206	0.257	0.257	0.232	0.192	0.138	0.0785	.....
0.3	0.151	0.198	0.196	0.170	0.126	0.0694	.....
0.4	0.111	0.144	0.141	0.110	0.0625	.....
0.5	0.079	0.103	0.091	0.0543	.....
0.6	0.057	0.066	0.0441	.....
0.7	0.035	0.0305	.....
0.8	0.0175	.....
0.9
1.0	1.000

TABLE 7. VALUES OF R FOR $\alpha = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.212	0.264	0.278	0.267	0.252	0.202	0.145	0.079	.....
0.2	0.169	0.225	0.235	0.232	0.188	0.137	0.076	.....
0.3	0.135	0.183	0.202	0.174	0.132	0.075	.....
0.4	0.099	0.150	0.139	0.107	0.063	.....
0.5	0.088	0.101	0.088	0.053	.....
0.6	0.038	0.060	0.042	.....
0.7	0.034	0.031	.....
0.8	0.021	.....
0.9
1.0	1.000

TABLE 8. VALUES OF R FOR $\alpha = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.146	0.204	0.227	0.235	0.231	0.187	0.141	0.078	.....
0.2	0.126	0.183	0.209	0.214	0.176	0.133	0.076	.....
0.3	0.116	0.166	0.188	0.161	0.122	0.072	.....
0.4	0.097	0.145	0.134	0.109	0.068	.....
0.5	0.085	0.095	0.088	0.058	.....
0.6	0.051	0.061	0.046	.....
0.7	0.031	0.030	.....
0.8	0.016	.....
0.9
1.0	1.000

TABLE 9. VALUES OF R FOR $\alpha = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.101	0.154	0.189	0.194	0.198	0.178	0.140	0.087	.....
0.2	0.104	0.161	0.180	0.187	0.173	0.133	0.079	.....
0.3	0.095	0.142	0.156	0.149	0.118	0.067	.....
0.4	0.057	0.113	0.123	0.101	0.060	.....
0.5	0.061	0.088	0.082	0.053	.....
0.6	0.051	0.060	0.040	.....
0.7	0.065	0.031	.....
0.8	0.022	.....
0.9
1.0	1.000

TABLE 10. VALUES OF R FOR $\alpha = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.069	0.118	0.153	0.174	0.178	0.164	0.124	0.069	.....
0.2	0.084	0.130	0.160	0.166	0.156	0.120	0.069	.....
0.3	0.083	0.127	0.149	0.144	0.110	0.069	.....
0.4	0.074	0.113	0.128	0.100	0.065	.....
0.5	0.059	0.088	0.080	0.052	.....
0.6	0.038	0.051	0.031	.....
0.7	0.017	0.013	.....
0.8	0.004	.....
0.9
1.0	1.000

T_s and T_r is obtained as follows: The shaded portion of the rim shown in Fig. 1 is equivalent to two continuous rings attached at the sides of the disk near the periphery. These two rings, if they were free, that is, not attached to the disk, would expand a good deal more than they do when integral with the wheel disk. This means that a part of the centrifugal force of the shaded section of the rim is carried by the disk,

and the remainder is self-supporting. A good approximation, in average cases, is to assume that two-thirds of the weight of the shaded portion of the rim is concentrated at the periphery of the disk. Calling this two-thirds weight W , the total weight of the blades, in pounds, attached at the periphery of the wheel W_b , the diameter at the center of gravity of the blades in feet D_b

TABLE 11. VALUES OF T_1 FOR $\alpha = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	2.020	1.263	1.122	1.073	1.051	1.038	1.031	1.026	1.022	1.020
0.2	2.080	1.505	1.300	1.207	1.156	1.125	1.105	1.091	1.082
0.3	2.200	1.720	1.496	1.375	1.302	1.255	1.222	1.199
0.4	2.380	1.955	1.720	1.580	1.489	1.426	1.381
0.5	2.680	2.270	2.020	1.860	1.750	1.670
0.6	3.120	2.800	2.440	2.250	2.120
0.7	3.920	3.460	3.140	2.920
0.8	5.560	4.980	4.560
0.9	10.560	9.540
1.0	CO

TABLE 12. VALUES OF T_1 FOR $\alpha = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.985	0.644	0.630	0.657	0.691	0.722	0.757	0.788	0.820	0.849
0.2	1.275	0.933	0.844	0.820	0.819	0.833	0.853	0.878	0.900
0.3	1.540	1.205	1.071	1.012	0.988	0.984	0.988	1.020
0.4	1.735	1.500	1.335	1.248	1.195	1.172	1.162
0.5	2.190	1.860	1.670	1.550	1.485	1.445
0.6	2.580	2.410	2.170	2.025	1.925
0.7	3.550	3.120	2.850	2.660
0.8	5.190	4.630	4.280
0.9	10.140	9.190
1.0	CO

TABLE 13. VALUES OF T_1 FOR $\alpha = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.456	0.322	0.353	0.408	0.470	0.539	0.600	0.654	0.703	0.781
0.2	0.764	0.571	0.540	0.559	0.604	0.650	0.694	0.735	0.797
0.3	1.058	0.835	0.759	0.749	0.760	0.782	0.807	0.882
0.4	1.315	1.180	0.982	0.940	0.924	0.923	1.023
0.5	1.750	1.500	1.400	1.304	1.252	1.290
0.6	2.250	2.000	1.846	1.711	1.715
0.7	3.186	2.846	2.576	2.490
0.8	4.926	4.346	4.100
0.9	9.760	9.000
1.0	CO

TABLE 14. VALUES OF T_1 FOR $\alpha = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.192	0.148	0.186	0.243	0.310	0.373	0.446	0.518	0.596	0.673
0.2	0.440	0.332	0.341	0.374	0.423	0.485	0.552	0.626	0.698
0.3	0.713	0.571	0.542	0.556	0.587	0.633	0.698	0.764
0.4	1.006	0.973	0.750	0.710	0.751	0.855	0.898
0.5	1.469	1.251	1.152	1.100	1.110	1.131
0.6	1.930	1.775	1.613	1.565	1.535
0.7	2.930	2.556	2.400	2.280
0.8	4.600	4.100	3.850
0.9	9.670	8.710
1.0	CO

TABLE 15. VALUES OF T_1 FOR $\alpha = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.077	0.066	0.099	0.147	0.206	0.272	0.349	0.429	0.522	0.616
0.2	0.240	0.188	0.204	0.246	0.303	0.373	0.451	0.539	0.633
0.3	0.466	0.380	0.371	0.398	0.451	0.514	0.596	0.684
0.4	0.768	0.645	0.607	0.617	0.654	0.717	0.791
0.5	1.172	1.012	0.940	0.925	0.952	1.000
0.6	1.710	1.526	1.395	1.355	1.365
0.7	2.716	2.425	2.170	2.090
0.8	4.344	3.910	3.650
0.9	9.250	8.420
1.0	CO

TABLE 16. VALUES OF R_1 FOR $\alpha = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.660	0.900	0.950	0.970	0.985	0.990	0.995	0.999	1.000
0.2	0.580	0.780	0.880	0.930	0.960	0.980	0.990	1.000
0.3	0.480	0.710	0.825	0.895	0.945	0.980	1.000
0.4	0.380	0.660	0.800	0.890	0.960	1.000
0.5	0.410	0.655	0.815	0.925	1.000
0.6	0.415	0.685	0.870	1.000
0.7	0.460	0.775	1.000
0.8	0.585	1.000
0.9	1.000
1.0	CO

TABLE 17. VALUES OF R_1 FOR $\alpha = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.450	0.601	0.698	0.767	0.844	0.878	0.920	0.962	1.000
0.2	0.406	0.594	0.709	0.814	0.863	0.915	0.969	1.000
0.3	0.375	0.580	0.735	0.813	0.890	0.948	1.000
0.4	0.357	0.600	0.728	0.837	0.933	1.000
0.5	0.385	0.605	0.770	0.903	1.000
0.6	0.375	0.645	0.855	1.000
0.7	0.440	0.760	1.000
0.8	0.580	1.000
0.9	1.000
1.0	CO

TABLE 18. VALUES OF R_1 FOR $\alpha = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.249	0.333	0.490	0.589	0.692	0.763	0.845	0.926	1.000
0.2	0.264	0.421	0.548	0.665	0.746	0.833	0.921	1.000
0.3	0.270	0.453	0.605	0.706	0.812	0.912	1.000
0.4	0.283	0.499	0.636	0.775	0.893	1.000
0.5	0.325	0.525	0.711	0.870	1.000
0.6	0.335	0.597	0.813	1.000
0.7	0.410	0.735	1.000
0.8	0.560	1.000
0.9	1.000
1.0	CO

TABLE 19. VALUES OF R_1 FOR $\alpha = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.131	0.234	0.335	0.440	0.557	0.656	0.767	0.881	1.000
0.2	0.170	0.298	0.417	0.532	0.646	0.764	0.883	1.000
0.3	0.197	0.353	0.490	0.619	0.747	0.870	1.000
0.4	0.228	0.407	0.565	0.717	0.860	1.000
0.5	0.257	0.470	0.663	0.829	1.000
0.6	0.310	0.570	0.787	1.000
0.7	0.403	0.713	1.000
0.8	0.535	1.000
0.9	1.000
1.0	CO

TABLE 20. VALUES OF R_1 FOR $\alpha = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.067	0.139	0.225	0.325	0.437	0.561	0.696	0.842	1.000
0.2	0.105	0.204	0.312	0.427	0.555	0.692	0.837	1.000
0.3	0.141	0.270	0.398	0.538	0.680	0.835	1.000
0.4	0.178	0.338	0.498	0.657	0.826	1.000
0.5	0.217	0.417	0.608	0.803	1.000
0.6	0.270	0.519	0.757	1.000
0.7	0.357	0.688	1.000
0.8	0.510	1.000
0.9	1.000
1.0	1.000

T₁ = S₁R₁ (7)

The values of T₁ and R₁ may be obtained from Tables 11 to 15 and Tables 16 to 20, respectively, for values of α between 0 and 2, in the same way as described for T and R.

From the foregoing it is possible to conclude that, in similar disks, where the values of α and m₀ are the same, and for the same peripheral speed and the same value of S₁, the stresses in the disks at points determined by the same value of m are exactly the same in a very large wheel and in a very small wheel. This point may be useful to keep in mind in carrying on experiments on small models of large wheels.

* * *

DECREASING THE LABOR TURNOVER

In a paper read before the American Society of Mechanical Engineers at the annual convention, December, 1917, Richard B. Gregg called attention to many interesting factors of value to employers in determining the causes for a large labor turnover, and pointed out that the percentage could be greatly decreased. There is, of course, a certain amount of labor turnover which is unavoidable and normal. A factory will always be losing employes from old age or death, marriage, changes of residence, or domestic conditions wholly uninfluenced by the character of the work or trade. This normal labor turnover will vary according to local conditions, but is probably about 20 per cent of the total working force. A turnover in excess of this percentage may be considered as an indication that some abnormal conditions are present, and the management should immediately take steps to determine the causes.

Determining Causes of Excessive Labor Turnover

The first thing to do is to examine the pay-roll and keep a record of the number of people hired and of those leaving or discharged in the entire factory for a given period, say one year. By comparing the total number of those leaving the company's employ with the total number of workers in the factory, the labor turnover, expressed as a percentage, may be obtained. In a thorough analysis it is also well to obtain the percentage of turnover for each department, or for each group working under one foreman. These percentages, when recorded, will usually point quite clearly to defects in the organization, unsuitable working conditions, or other factors which tend to increase the turnover.

In carrying the analysis further, it is well to group those who leave according to their actual earnings, which will show the significance of the wage factor as a cause for leaving. In one case, such an analysis made it possible to ascertain that in one department, where the turnover was unusually high, the reason was that the men were receiving fifty cents a week less than men doing similar work elsewhere in the same town. The wages were raised fifty cents and the men did not leave their jobs as in the past. Usually, the largest percentages of shifting labor will be found in the low-paid groups.

A further aid in determining the causes of a high percentage of labor turnover is to make inquiries from the foremen and from the men who leave. Too much reliance should not be placed upon information obtained in this way, however, as it is very likely to be distorted by personal opinions. It is a valuable aid, however, in determining some of the underlying causes. Sometimes these are very simple, as in the case of a machine-building concern which learned that most of the men who left resided a considerable distance from the plant. By giving preference to applicants living near the plant, the turnover was gradually greatly reduced. Usually, however, there is a complex set of causes.

Cost of Losing a Worker

The cost of losing an old worker and hiring and training a new one is high. It may be roughly divided into overhead cost and operating cost. Among the overhead costs are: (1) More rapid depreciation of machinery, because of ignorance or lack of skill of new workers. (2) Extra floor space and extra machines to provide against idleness of a certain amount of machinery due to shifting labor.

Among the operating costs the following may be mentioned: (1) Time spent by the foreman or superintendent in discharg-

ing a worker. (2) Time spent by the foreman or other workers in training the new employe. (3) Time spent by clerks on additional pay-roll or other records. (4) Time machinery is idle when a new worker cannot be obtained immediately. (5) Idle machinery or temporary stoppages due to ignorance or lack of skill of new worker. (6) Repairs to machines or renewals of tools broken for the same reason. (7) Waste or damaged material due to ignorance or lack of skill of new worker. (8) Difficulties in subsequent processes due to poor work by new employes in previous processes. (9) Lower production while new employe is working up to his best skill. (10) Additional accident cost due to higher rate of accidents among new employes.

Those who have made the most careful studies of this question find that it costs about \$10 to replace an ordinary laborer and as much as \$300, and perhaps more, to replace a skilled worker. Mr. Alexander, of the General Electric Co., estimates the losses in a group of twelve metal-working factories in a single year to have been not less than \$831,000. In another case, the annual loss from a high labor turnover in a plant employing 2000 men was estimated at \$20,000. It should be remembered, moreover, that none of these estimates include the losses to the employes themselves or to the community. The subject is, therefore, one of the greatest importance, and it is to be expected that more and more attention will be given to it in the future. Just as about ten years ago industrial managers began to realize the enormous waste due to accidents, and set out to take steps to prevent the waste incident thereto, so it is probable that during the next decade attention will be paid to the enormous waste incident to the constant shifting of labor.

* * *

THE NEW ZEPPELINS

The Zeppelins that came to an untimely (?) end in France a few months ago were 643 feet in length, had a total height of 114 feet, and consisted of eighteen balloons enclosed inside an aluminum framework, these balloons containing over one million cubic feet of hydrogen. The total lifting capacity was 55 tons. As the aluminum structure weighs between ten and twelve tons and the five motors, each of 240 horsepower, together with the weight of the cars, balloons, etc., weigh several tons, the actual carrying capacity of the complete Zeppelin may be estimated at about thirty-five tons. This weight is mainly made up of the weight of the crew, fuel, ballast, provisions and other necessary appliances required for the journey, leaving about 2½ tons for explosives. These Zeppelins are built with a view to flying at a height of between 16,000 and 20,000 feet. At such an altitude their designers apparently considered them reasonably safe from both shells and heavier-than-air craft, but as a matter of fact there appears to be some slight error in these calculations, since one Zeppelin was brought down from a height of over 16,000 feet. The Zeppelins with all their motors working at full power can travel at more than sixty miles an hour. Three of the motors are in the forward and in the two middle cars, while the stern car carries two motors, each car carrying only one propeller. As a rule, only four motors are used, the fifth being held in reserve. The commander is in the forward car with the greater part of the crew. The total crew for short raids consists of twenty men, and for long raids, of eighteen men.

* * *

BONUS FOR PUNCTUALITY AND ATTENDANCE

A method has been adopted by the Cincinnati Planer Co., Cincinnati, Ohio, for encouraging employes to secure a perfect record for punctuality and attendance. Eleven of the employes of the company who were never late or absent during the twelve months from December 1, 1916, to December 1, 1917, were awarded a 5 per cent bonus on their yearly earnings, this 5 per cent being in addition to the regular 5 per cent on the earnings provided for by the company's Christmas fund. The eleven men who were thus awarded were Charles Marschel, George Hoemschmeyer, C. Corum, J. Murphy, J. Eisenbrey, N. Doggendorf, Charles Tope, E. Oder, J. Byrum, John Behrens and J. L. Ballman.

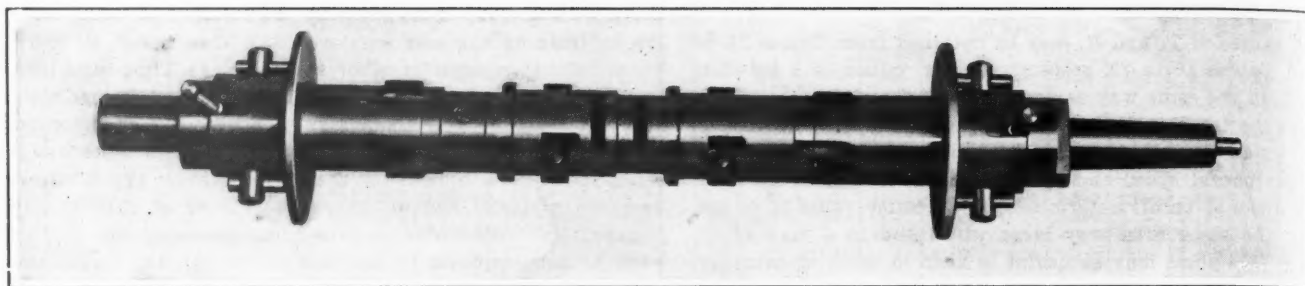


Fig. 1. Murchey Combination Boring, Reaming, Chamfering and Tapping Tool

COMBINATION TOOLS AND THEIR APPLICATION

TOOLS FOR PERFORMING A SERIES OF OPERATIONS AT ONE SETTING OF THE WORK

IN many lines of manufacturing, competition has become so keen that a great deal of time may often be profitably spent in planning methods of performing machining operations and designing special tools with the view of making what may appear to be only slight savings in the cost of production. Nevertheless, there are many factories where these very small savings represent the difference between manufacturing the piece at a profit and at a loss; and when these savings per piece are multiplied by the yearly production of a large plant, the importance of careful planning of the methods of machining and pains taken with the designing of tools at once becomes apparent.

the work. With the view of explaining how these tools operate, a description is given of four typical tools and of the work done by them. While these are representative examples of the combinations of operations, for the performance of which a single tool may be designed, the tools shown do not represent by any means all of the combinations which are possible.

In Figs. 1 and 2 there is shown a combination boring, reaming, chamfering and tapping tool developed for the purpose of machining automobile differential gear housings of the type shown in Fig. 3. The tool consists of two sets of cutters, comprising boring, reaming and chamfering bits and a collapsing tap, carried in a single bar. In this case the use of this com-

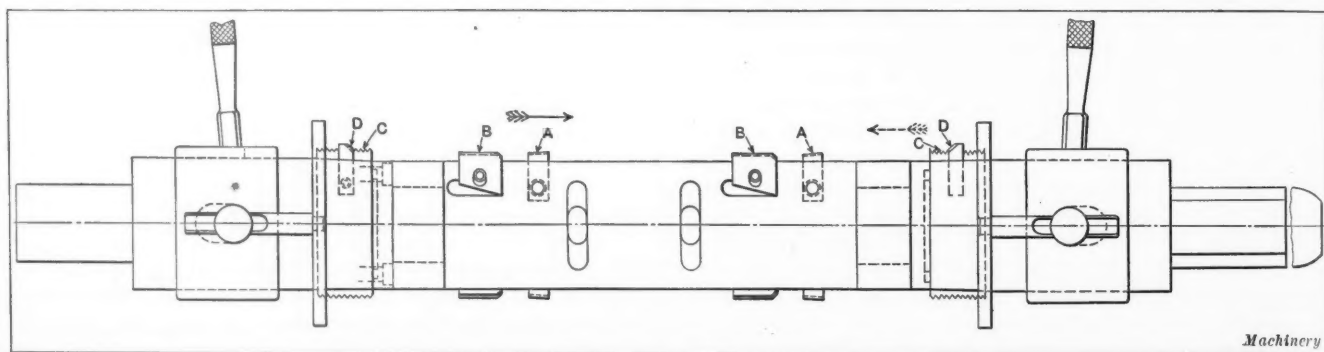


Fig. 2. Detail View of Combination Tool shown in Fig. 1

It is a matter of general knowledge among experienced mechanics that the time involved in setting up a piece of work ready for the performance of a machining operation often takes longer than the actual machine work that is required on the piece, and when there is a sequence of operations to be performed, this item of setting-up time may become a serious limiting factor. With the idea of overcoming this limitation imposed upon the rate of production on pieces where a series of operations has to be performed, the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich., has developed a number of interesting tools which provide for the performance of a series of operations, including boring, reaming, facing, chamfering, turning, threading and tapping, at a single setting of

combination tool is not only the means of increasing the rate of production by enabling all of the operations to be performed at a single setting of the work, but, in addition, performance of the boring, reaming, chamfering and tapping operations in each of the two holes in the work with a single tool is the means of assuring accurate alignment between the two holes, which is a matter of the utmost importance. After the tool has been set up, each hole in the work is located to the right of the boring and reaming cutters A and B; then, as the tool is fed to the right, cutters A bore the two holes in the work and these holes are then reamed by cutters B. This movement of the tool to the right is continued until one of the holes has been tapped and chamfered by cutters C and D; and when this

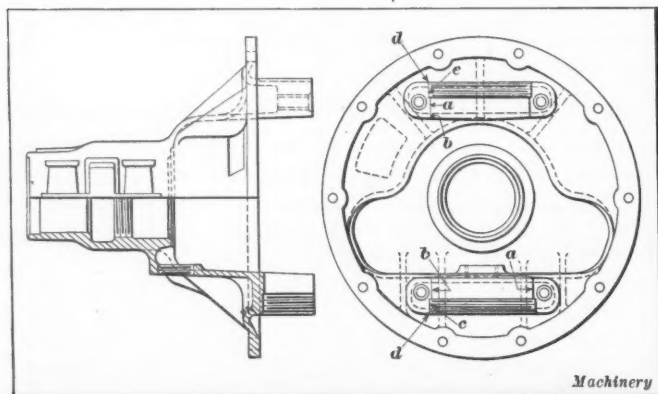


Fig. 3. Automobile Differential Gear Housings machined by Tools shown in Figs. 1 and 2

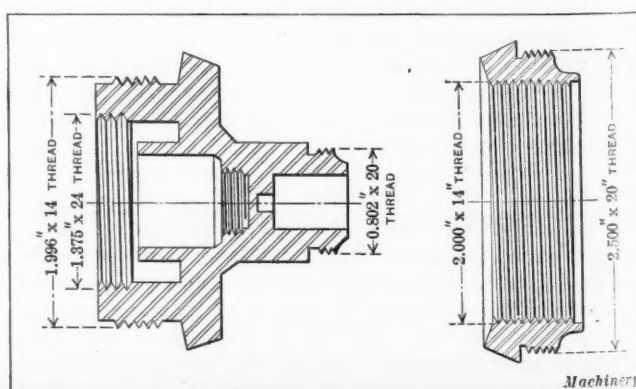


Fig. 4. Work threaded by Combination Threading Die and Tap shown in Fig. 3

result has been accomplished, the direction of movement of the tool is reversed in order that the other pair of cutters *C* and *D* may tap and chamfer the other hole in the work. In Fig. 3, *a*, *b*, *c* and *d* indicate the work done by the cutters *A*, *B*, *C* and *D* in Fig. 2.

In Fig. 5 is shown a combination tool which provides for boring and reaming one hole, reaming and tapping a second hole, and chamfering and facing the surface at the top of the tapped hole. This tool consists of a combination of the required boring, reaming, chamfering and facing cutters and a collapsing tap. The work is an automobile differential case. In this illustration the tool is shown in operation, so that a brief description will suffice to explain the way in which it works. In each case it will be seen that capital and small letters are employed to indicate the cutting tool and the portion of the work on which it operates, respectively. The order

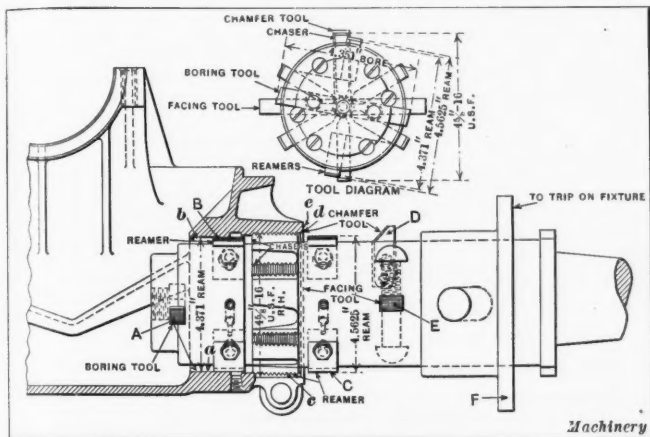


Fig. 5. Combination Boring, Reaming, Chamfering, Facing and Tapping Tool for machining Automobile Differential Case

of operations is as follows: Cutter *A* bores hole *a* to a diameter of 4.351 inches; cutter *B* reams hole *b* to a diameter of 4.371 inches; cutter *C* reams hole *c* to a diameter of 4.5625 inches; cutter *D* cuts a 45-degree chamfer *d* at the top of hole *c*; and cutter *E* faces surface *e*. During the time that these operations are being performed, the chasers of the tap are collapsed; the tool is next drawn back and the tap expanded, after which it is again fed into the work to provide for tapping hole *c*. Collar *F* engages a trip on the fixture to provide for automatically collapsing the tap. A little thought will suffice to show the great increase in production which is made possible through being able to perform all of these operations at a single setting of the work.

So far, we have been concerned only with the performance of internal machining operations, but the combination tools made by the Murchey Machine & Tool Co. are not in any sense restricted to this class of service. Fig. 6 shows the combination of a set of turning and facing cutters and a self-opening threading die, which is used for machining the piece shown in Fig. 7. The operation of machining this piece is divided into two parts; first, the tool is fed over the piece with threading die chasers *A* collapsed, so that the four combina-

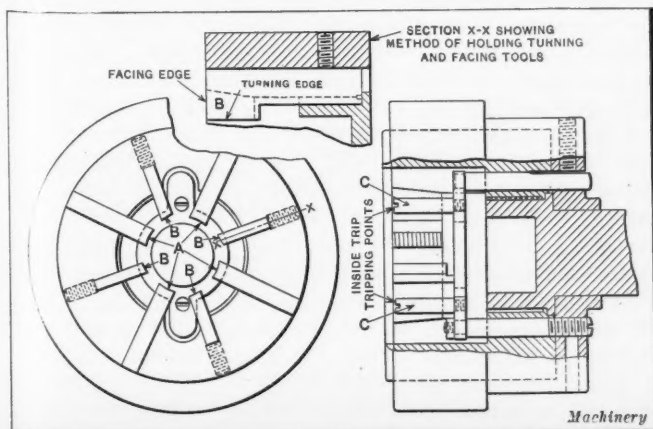


Fig. 6. Combination Turning, Facing and Threading Tool for machining Piece shown in Fig. 7

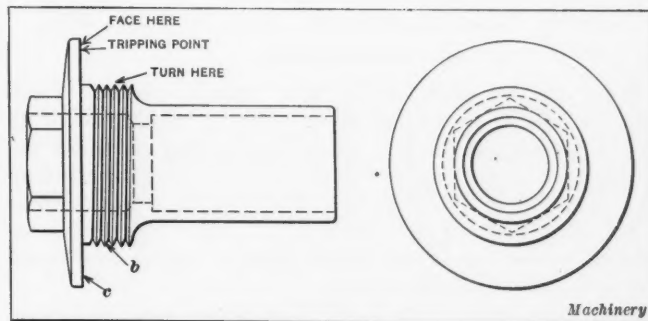


Fig. 7. Piece which is turned, faced and threaded by Tool shown in Fig. 6

tion turning and facing tools *B* may turn section *b* on the work and face surface *c*. The form of these combination turning and facing tools will be best understood by referring to the cross-sectional view of the tool on the line X-X. After the first part of the operation has been completed, the tool is withdrawn from the work and the threading chasers *A* expanded, after which the tool is again moved forward to provide for cutting threads *b*. This automatic die is of the type provided with an inside trip which is operated by having trip-points *C* engaged with surface *c* on the work.

In the manufacture of fuses for shrapnel and high-explosive shells, the necessity has arisen for machining various parts on which there is an internal and an external thread. To provide for handling this work in the most expeditious manner, it is obviously desirable to perform the internal and external threading operations simultaneously. Fig. 8 shows a combination threading die and tap which the Murchey Machine & Tool Co. has developed to meet the requirements of this work, and in Fig. 4 are shown two examples of the kinds of work for which this tool is adapted. The tool consists of a combination

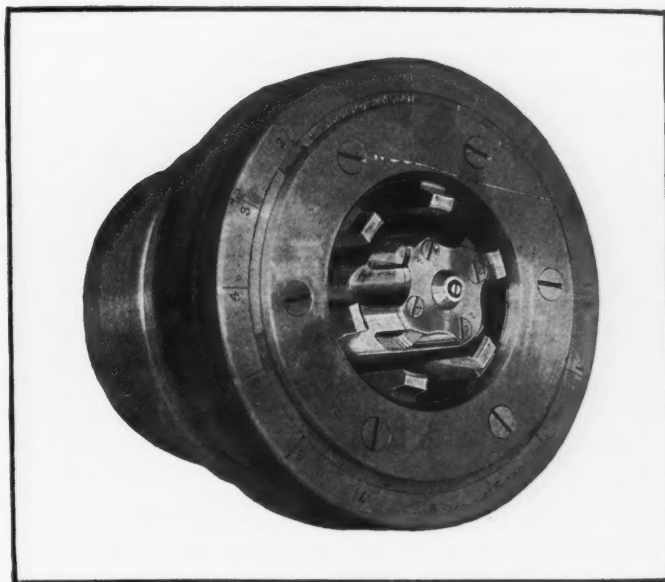


Fig. 8. Combination Threading Die and Tap for threading Work shown in Fig. 4

sizing tap and threading die, and both the tap and the die are furnished with means of adjustment to control the size of the work. To provide for handling work where the pitches of the internal and external thread are not the same, the tap is made free to move longitudinally in order to compensate for the difference in rate at which the tap and the die must be advanced while performing their respective operations. Although this type of tool was especially developed to meet the requirements of firms engaged in the production of fuse parts, it will be apparent that there are a variety of other threaded parts on which it could be used with excellent results. E. K. H.

* * *

The magnitude of the operations to be undertaken by the American forces in France is indicated by the fact that the government has purchased 150,000 tons of eighty-pound rails for use overseas, which is equivalent to 600 miles of double-track line.

CARD INDEX PRODUCTION SYSTEM

BY LEWIS JOHNSON¹

There are two objections to most routing systems: First, they are written upon large sheets of paper, usually about fifteen by twenty-four inches, which makes them extremely unhandy; and, second, no provision is made for parts made up later on an order to replace spoiled work or defective castings or for parts that are sent twice to the same department for different operations or on which there is some intermediate operation in another department.

The routing card shown in Fig. 1 takes care of all these contingencies. It measures only four by six and one-half inches and is very flexible, yet the writer has never seen its use suggested in any text-book. The card gives the part number and name of the pieces and the material from which they are to be made, the requisition number upon which it was ordered, the lot and job numbers upon which the pieces are to be used, and the date the order was made out. It also states if this material is special, and each department bears a number. To illustrate its purpose, the card is filled out for a piece that has not been manufactured before. This case will especially

ROUTE CARD							
Symbol		A60					
Material		b.d.		Req.		2654-5 2590	
Lot No.		591		Job No.		6872	
Part Name		Front Apron		Quan.		50	
Date		Sept. 19, '17					
DEPARTMENT NO.	NAME	Quan.	Date	Quan.	Date	Quan.	Date
1	Pattern-shop						
2	Foundry	Pattern	9-26-17				
3	Casting Shed	50	10-8-17	5	10-20-17		
4	Steel Racks						
5	Screw Machines						
6	Gear and Milling						
7	Planers	50	10-10-17	5	10-23-17		
8	Lathe and Grinding						
9	Drills	50	10-28-17			50	11-3-17
10	Blacksmith						
11	Vise and Polishing						
12	Unit Assembly	50	10-30-17				
13	Planer Fitting						
14	Paint	50	11-5-17				
15	Stock-room	50	11-12-17				
16	Defective	5	10-16-17				

Fig. 1. Routing Card

apply to any concern building special machinery, but the quantity of pieces made on an order would be probably smaller. The card shows that the pattern shop delivered the pattern to the foundry store-house on September 26, that fifty castings were finished and in the shed on October 8, and were delivered to the planer department on October 10. A receipt, shown in Fig. 2, is given by each department for all material it receives. On the planer operation, five castings were found to be defective, so a green rush tag was issued for castings to replace these. These were ordered from the foundry on requisition No. 2654, were delivered to the casting shed on October 20, and sent to the planer department on October 23, where they

¹ Production Manager, Hamilton Machine Tool Co., Hamilton, Ohio

DEPARTMENT		TRANSFER RECEIPT	
NO.	NAME	Lot No.	Job No.
1	Pattern-shop	591	6872
2	Foundry	Symbol	A60
3	Casting Shed	Name	Front Apron
4	Steel Racks	Quantity	50
5	Screw Machines	From Dept. No.	3
6	Gear and Milling	To Dept. No.	7
7	Planers	Received By	J. Smith
8	Lathe and Grinding	Date	October 10, '17
9	Drills		
10	Blacksmith		
11	Vise and Polishing		
12	Unit Assembly		
13	Planer Fitting		
14	Paint		
15	Stock-room		
16	Defective		

Fig. 2. Transfer Receipt

were planed and sent forward, with the other forty-five pieces, to the drilling department on October 28, and from there to the unit assembly department. On November 3 the work was returned to the drilling department for further drilling, and was then sent to the painting department on November 5, and finally to the stock-room on November 12. If, in the stock-room, some of the pieces failed to pass the final test and could not be used, another green tag would have been made out for the rest, and the replacement carried through as before.

The classification chart, Fig. 4, shows how these cards may be sorted into special groups; of course, in each group the cards run with the symbols in numerical order, and are filed with the cards constituting each order for machines separately. Group 1 contains route cards for all orders for parts made from castings, the patterns for which are not yet completed. As the patterns are made and delivered to the foundry store-house, an entry is made on that particular card and the card placed in Group 2; thus Group 1 grows smaller and smaller. At regular intervals, a shortage slip is made out and delivered to the pattern-shop boss, so he can tell where to concentrate the energies of his force. This also insures that patterns for such pieces as are made from special material or

ORDER TAG	
Lot No.	591
Job No.	6872
Symbol	A60
Part Name	Front Apron
Quantity Required	50
PRODUCTION REPORT	
Lot No.	591
Job No.	6872
Symbol	A60
Quantity O.K.	
Quantity Defective	
Signed	
Date	
MATERIAL CREDIT	
Lot No.	591
Job No.	6872
Symbol	A60
Material	b.d.
Quantity	lbs. \$
Signed	
Date	
Note: Return this part of tag to stock-keeper with any stock left over on this job.	
MATERIAL CHARGE	
Lot No.	591
Job No.	6872
Symbol	A60
Material	b.d.
Quantity	lbs. \$
Signed	
Date	
Note: Fill in weight of stock drawn out for this job and return part to cost office. If material is castings return both charge and credit.	

Fig. 3. Order Tag

cast outside the plant are made ahead of the rest of the patterns and sent out to the foundries. As the castings are made in the foundry, they are sent through the castings shed, and when there are enough to satisfy the order they are sent to the machine department. When the receipt for this transaction comes into the office, the entry is made on the card, which is in Group 2, and the card is filed in Group 3. As all castings are finished, Group 2 will be finally eliminated, and, if necessary, shortage slips can be made out from time to time on the foundry. There are now left only Groups 3, 4 and 5, and as the parts are finished and sent to the stock-room ready for assembling, Groups 3 and 4 are assimilated by Group 5, which is the only group that remains at the end. Of course, where any parts have proved defective or been spoiled, rush tags have been made out to replace those parts. These rush tags bear the same lot and job number as the original order, and the work is pushed through to the stock-room, so that the order is soon completed and ready for assembling.

The transfer receipt, shown in Fig. 2, is four by five and one-half inches and is furnished in duplicate in pads of fifty each. One copy is then sent to the production office and the

made to replace defective or spoiled pieces and which follows exactly the same routine enumerated above.

The advantage of this system is that most of the clerical work is performed in the office, and as a good mechanic is seldom either an expert chirographer or bookkeeper, this eliminates the chances for error and also reduces to a minimum the number of forms required, thereby simplifying the working system. On the route card, no provision is made for the cost record figures, but the reverse side of the card may be used for this purpose. This card was designed and intended to fit one particular shop. Many forms fail in their purpose simply because they have been copied piecemeal from some form that is doing excellent duty in the first plant but which fails to fit the conditions in the second plant. Care must be taken with the receipt form and with the numbering of the departments to have everything clearly defined and nothing ambiguous, so that the entries on the route cards may be made correctly by a junior clerk (the writer has found girls much more careful and thorough for this class of work than boys); this leaves the production man's time open for more important work.

* * *

METHODS OF WAGE PAYMENT

In the Pittsburg district, increases in wages during 1917 were made in a number of different ways, including the payment of bonuses, straight increase in time rates, and increases by means of premium, piece-work and tonnage rates. Twenty-nine per cent of the employers pay a bonus in addition to the regular wages. Twenty-two per cent use the premium plan in which a certain time is set for the completion of an operation, and if the workman completes the task in less than the time set, he is paid a certain percentage, usually one-half, of the saving thus effected. Twenty-nine per cent of the employers use the piece-work plan for all wage payments. In some cases even common laborers, truckers and loaders are paid by the ton or piece for all the work done. In 10 per cent of the cases a bonus is paid upon the tonnage output and the number of hours worked, this being an incentive to put forth the best efforts and to discourage absence from work. In 10 per cent of the cases, straight wage increases have been paid without the use of bonus, premium or piece-work plans. Bonuses are frequently paid in separate envelopes and on separate days from the regular pay days. In some cases the bonuses are paid at the same time as the regular wage payments, but are marked on the outside of the envelope in red ink as "Bonus." Generally the bonus is from 10 to 20 per cent of the regular wages. In some cases, a 5 per cent bonus is paid after two months' employment, and then an increase of 1 per cent is made for every two months of employment until 10 per cent is reached. In other cases the additional percentage is continued until 20 per cent is reached. Some firms also have paid an additional bonus of 8 per cent based upon punctuality and attendance to business. Absence from work without permission forfeits the bonus, but absence on account of sickness or other unavoidable causes does not deprive the employe of his share. It has been noted that the payment of a certain percentage of the regular wages in the form of bonuses under these conditions has resulted in regular attendance at work, so that there has been a marked decrease in the days and hours lost.

In the Pittsburg district, the customary allowance for over-time is time and one-half, except on Sundays and legal holidays, when double time is paid. Over-time commences after fifty-four hours for the week have been completed. Over-time and long hours are the rule rather than the exception, and from the present outlook this will continue to be the condition throughout the duration of the war.

* * *

Norway's first reinforced-concrete ship was launched in three weeks from the time work on it was begun. As the forms can be used for all other ships of this size, it is expected that all later ships will be ready for launching in one-half this time. It is thought, too, that the ships of 1000 tons that are being planned can be launched in six weeks after work is begun.

CLASSIFICATION FOR ROUTE CARDS.	
Group 5	Orders for pieces which have been completed and are in finished stock-room awaiting assembly.
Group 4	Orders for pieces made from steel in process of manufacture.
Group 3	Orders for pieces made from castings which have been completed by foundry and are now in process of machining.
Group 2	Orders for pieces made from castings the patterns for which are completed and in foundry.
Group 1	Orders for pieces made from castings the patterns for which are not yet completed.

Fig. 4. Classification Chart

other to the foreman from whom the material has just been received.

The order tag, shown in Fig. 3, is made out in the production department, attached to the blueprint and sent to the raw stock-room. If the parts are made from castings, the weight is filled in and the two lower parts detached and sent to the office. The two upper parts, with the blueprint and castings, are sent to the machine department. If the parts are made from steel pieces sawed from the bar, a similar procedure is followed. In the case of screw machine parts, the bar of steel or brass is weighed and the weight filled in on the lowest part of the tag, which is detached and sent to the office. The rest of the tag, with the blueprint and bar stock, is sent to the machining department. When the job is finished, the part headed Material Credit is returned with the surplus stock to the raw stock-room, where the weight is filled in and the slip is sent to the cost office. If there is no stock left over, the slip is so marked and returned to the raw stock-room and thence to the cost office. The two upper parts of the tag, with the blueprint, remain with the job through all the machine operations to the finished stock-room. After being inspected, the second part of the tag is detached and sent to the cost office, while the top part of the tag remains with the pieces as a means of identification. A similarly printed tag, but colored green and headed rush, is used as an order for those pieces that are being

THREAD-CUTTING ATTACHMENTS¹

STANDARD AND SPECIAL MECHANISMS AND ATTACHMENTS FOR ENGINE LATHES, TURRET LATHES, DRILLING AND BORING MACHINES

BY FRANKLIN D. JONES²

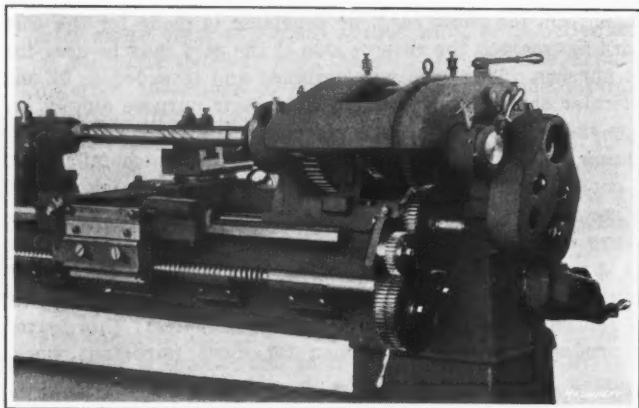


Fig. 1. Attachment for cutting Threads of Coarse Pitch or Large Lead

A SPECIAL mechanism or some form of attachment may be used in connection with thread-cutting operations either in engine lathes, turret lathes, or other classes of machine tools which may or may not be employed ordinarily for work of this kind. An attachment is sometimes applied to an engine lathe for cutting a screw thread of unusually large lead or for other special operations, such as cutting threads which differ slightly in pitch from the standard pitch. Thread-cutting attachments are also applied to some turret lathes, so that threads may be cut by means of a single-point tool or chaser whenever a tap or die cannot be used to advantage.

Attachments for Cutting Screws of Large Lead

When a lathe is used for cutting a screw thread of exceptionally large lead, or steep pitch, the change-gear mechanism may be subjected to excessive stresses if the power for traversing the carriage along the bed is transmitted from the lathe spindle to the lead-screw in the usual manner. This is due to the unusual distance that the carriage must move along the bed per revolution of the work in order to obtain a large lead. For instance, if the lead is such that the lead-screw must be revolved quite rapidly to move the carriage and tool a distance equal to the lead of the thread, each time the spindle makes one revolution, the teeth, especially on the first gear of the train, may be broken as a result of the excessive stress. One method of avoiding trouble of this kind is to apply power directly to the lead-screw, instead of to the spindle; motion is then transmitted from the high-speed member of the gear train to the low-speed member, as the lead-screw drives the spindle, and the load on the gear teeth is reduced. Another method of overcoming this difficulty is by driving the lead-screw from the gear on the cone pulley, a special "attachment" or gearing being used to transmit the motion. On one design of lathe arranged in this way, the cone pulley has a velocity ten times that of the spindle when the back-gears are engaged; consequently, by using the rapidly revolving cone gear as the driver in the train of gearing connecting with the lead-screw, the stress on the teeth is reduced proportionately. If we assume that the lead of a screw to be cut is $3\frac{1}{2}$ inches, and that there are 4 threads per inch on the lathe lead-screw, the ratio of the spindle speed to that of the lead-screw is 14 to 1. By driving directly from the cone gear, however, the ratio will be changed to 14 to 10, because the cone pulley revolves ten times as fast as the spindle; therefore, the power necessary for traversing the carriage is easily transmitted through the gearing, and without overstressing the teeth. The gearing on a coarse threading attachment of this kind may be arranged as follows: A double sliding gear on the reversing shaft inside of the headstock can be engaged either with the regular driving gear on the spindle or with a small gear at the end

of the cone pulley. For cutting threads of large lead, the sliding gear is engaged with the cone gear and the back-gears are thrown into mesh. The sliding gear will then make ten revolutions to one of the spindle; consequently, if the lathe were geared to cut one thread per inch, it would cut a thread groove having a lead of ten inches when driving through the sliding gear and cone pinion. An attachment of this kind may be used for cutting oil-grooves in cylindrical parts and for similar operations, as well as for cutting screws of large lead.

Special Lead-screw for Cutting Threads of Coarse Pitch

A rear view of a Lodge & Shipley lathe having a special lead-screw for cutting threads of large lead is shown in Fig. 1. This auxiliary lead screw extends along the rear side of the bed, and when in use the back-gearing of the headstock is engaged; the drive is then from the large back-gear, through the change-gearing shown, to the special lead-screw. A long half-nut at the back of the carriage engages the threads of the lead-screw and is so arranged that it may be raised or lowered by a cam operated by a handwheel at the front of the apron. The lead-screw is supported on the under side by a number of long shoes attached to the lathe bed. This lathe is equipped with the regular quick-change gear mechanism and a lead-screw at the front for ordinary thread-cutting operations with leads ranging from $1/32$ inch to 2 inches. The coarse-pitch threading attachment is used for leads varying from 2 to 15 inches.

Cutting Threads so that Pitch is Slightly Greater or Less than Standard

It is sometimes necessary to cut a screw thread having a pitch which is slightly greater or less than standard. A very small increase of pitch may be required in order to allow for shrinkage of the steel in hardening, or if a screw is to be fitted into a hardened part having an internal thread, it may be necessary to make the pitch of the screw thread less than standard on account of shrinkage in the nut or other part which is to receive the screw. A slight increase in pitch may easily be obtained by means of a taper attachment, but cutting a pitch less than standard is more difficult.

When a taper attachment is used to increase the pitch slightly it is set at an angle and the part to be threaded is located at the same angle by adjusting the tailstock center; consequently, the thread tool will cut a straight thread or one of uniform diameter throughout its length, but as the tool point moves along an angular path relative to the movement of the carriage, it travels farther than the carriage. The result is that the pitch of the thread cut by the tool is a little greater than the pitch for which the lathe is geared. The amount that the pitch is increased depends upon the angle between the axis of the work (or the angle to which the taper attachment is set) and a line representing the movement

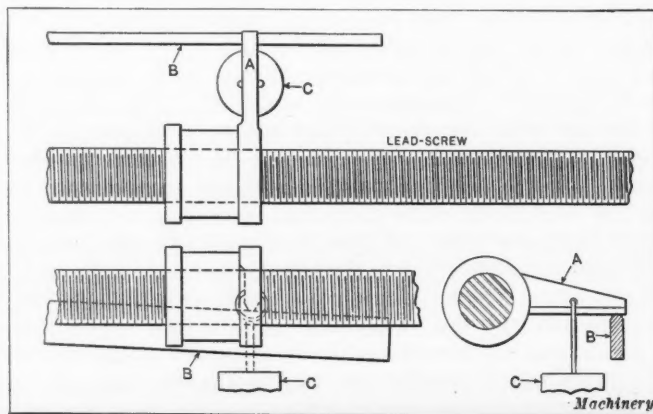


Fig. 2. One Type of Attachment for obtaining Slight Variations in Pitch or for correcting Lead-screw Errors

¹ For previous information on this subject, see "Thread Milling," January, 1918, and articles there referred to.

² Associate Editor of MACHINERY

of the carriage. The cosine of the angle to which the work and taper attachment should be set for obtaining a given increase in pitch equals the standard pitch (obtained with the regular gearing) divided by the increased pitch necessary to compensate for shrinkage.

If a screw thread must be cut having a pitch slightly less than standard, special equipment is required. One method is to provide special gears which give a somewhat greater reduction of pitch than is necessary. The taper attachment is then used, as previously explained, to increase the pitch so that it is below the standard just the right amount. For instance, if the required pitch is 0.198 inch instead of the standard of 0.200 inch (five threads per inch) gears having 83 and 84 teeth, respectively, could be used to form a compound train of gearing and reduce the 0.200-inch pitch obtained with the regular change-gears.

This reduction would equal $83/84$ of 0.200 inch, or 0.1976 inch. In order to increase the pitch of 0.1976 inch to 0.198 inch, the taper attachment and work are set at an angle the cosine of which equals 0.1976 divided by 0.198 equals 0.9979 , which is the cosine of 3 degrees, 40 minutes. As this example indicates, the pitch for which the lathe is geared is divided by the pitch required, to obtain the cosine of the angle.

Special Attachment for Obtaining Slight Variations in Pitch

Lathes that are used extensively for precision screw cutting are sometimes equipped with special compensating attachments for varying the pitch. These attachments may be used in some cases to cut screw threads which differ slightly from the standard pitch, as when an allowance must be made for shrinkage, or the attachment may be used to compensate for slight inaccuracies in the lead-screw in order to cut threads to a given pitch within as close limits as possible. Most of these attachments are designed to vary the pitch either by imparting a turning movement to the nut engaging the lead-screw, or by shifting the lead-screw itself in a lengthwise direction. The diagram Fig. 2 illustrates how slight variations may be obtained by turning the lead-screw nut or as a result of a differential motion between the lead-screw and the nut connecting with the tool carriage. A nut of special form is mounted in a bracket attached to the carriage so that it is free to turn. Projecting from this nut there is an arm *A*, the end of which is held firmly against the edge of a compensating strip *B* by weight *C*. The strip *B* can be set in an inclined position, so that when arm *A* is traversed along it, the nut is turned in one direction or the other, thus increasing or decreasing the pitch of the thread cut by the lathe, by advancing or retarding the movement of the carriage.

The diagram Fig. 3 illustrates a type of compensating attachment which operates by moving the lead-screw axially.

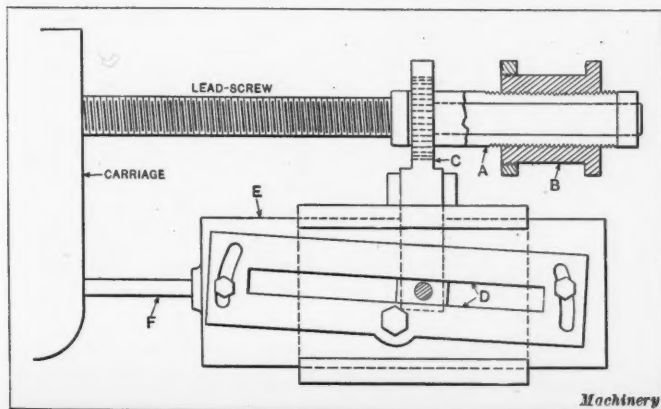


Fig. 3. Another Form of Attachment for obtaining Slight Variations in Pitch

The lead-screw bearing at one end is in the form of an externally threaded sleeve *A*, which is screwed into an outer stationary sleeve *B*. The lead-screw is free to rotate in sleeve *A*, but it cannot move in a lengthwise direction relative to *A* except when the latter is screwed in or out of sleeve *B*. The turning movement of sleeve *A* for varying the pitch is derived from a pinion attached to *A* which meshes with a rack *C* hav-

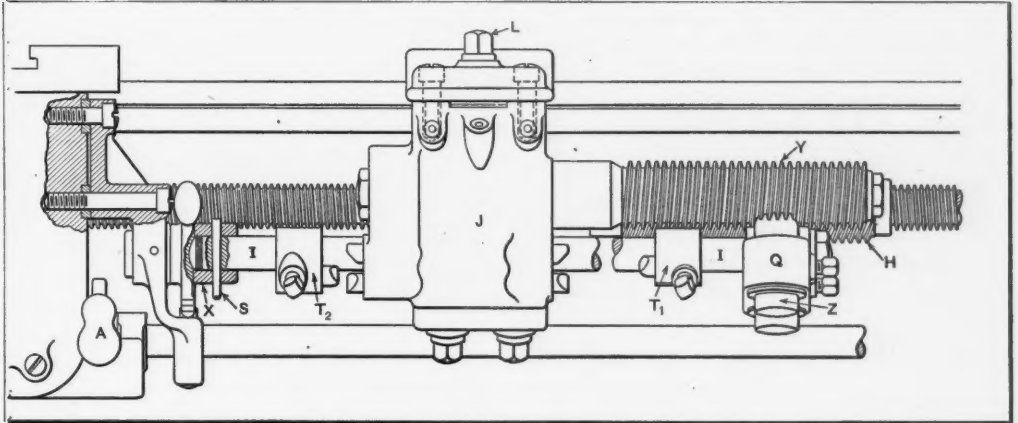


Fig. 4. Quick-threading Attachment for Engine Lathe

ing at its lower end a block engaging a slot in plate *D*. This plate *D* is attached to a slide *E*, which is connected to the lathe carriage by a rod *F*; consequently, slide *E* and plate *D* move with the carriage, and when slot *D* is in an angular position the resulting vertical movement of rack *C* turns sleeve *A* and shifts the lead-screw, thus varying the pitch of the thread cut by the lathe.

Translating Gears for Metric Pitches

Lathes used for cutting threads based on either the English or metric systems of measurements may be provided with translating gears. There are two gears having 50 and 127 teeth, respectively. The numbers of teeth in these gears represent the relation between the English and metric systems of measurement; thus 1 inch is equivalent to 2.54 centimeters,

and $\frac{1 \times 50}{2.54 \times 50} = \frac{50}{127}$. When these gears are in the train of

gearing connecting the lathe spindle and lead-screw, the lathe may be geared for cutting a given number of threads per centimeter by using, in addition to the translating gears, the same gears that would be employed for cutting a similar number of threads per inch. For example, if a metric thread is to be cut having a pitch of 2 millimeters, or 5 threads to the centimeter, and translating gears are used, change-gears for cutting 5 threads per inch could be employed. In this case, 5 threads to the centimeter will actually be cut and not 5 threads to the inch, because the translating gears are used in conjunction with the regular gears, thus forming a compound train of gearing. If the gears for cutting 5 threads per inch should have 36 and 30 teeth, respectively, on the stud and lead-screw, the compound train of gearing for cutting 5 threads per centimeter would consist of driving gears having 50 and 36 teeth and driven gears having 127 and 30 teeth. The positions of either the driving or the driven gears could be transposed, if necessary, in order to make the gears mesh together properly.

Quick-threading Attachment for Engine Lathe

The Hendey quick-threading attachment shown in Figs. 4 and 5 is intended especially for cutting comparatively short threads on duplicate parts varying from one to three inches in length, although it may be used for lengths up to six inches. Thread cutting can be done rapidly with the attachment owing to the high speed at which the carriage is returned from the end of the cut to the starting point. This rapid-return movement is effected by a quick-return sleeve having a multiple thread of coarse pitch. This return sleeve, as well as the thread chasing sleeve from which the forward movement is derived, rotates constantly when the attachment is in use. The length of the travel in either direction is governed by automatic trip dogs. The chasing sleeve *Y* and the quick-

return sleeve *H* are geared together and rotate at the same speed as the lead-screw. The nuts *Z* and *Z*₁, attached to rocker *Q*, may be engaged with the sleeves. Rocker *Q* is connected with the apron by means of push-shaft *I* through the handle indicated at *X*. When the split nut in the apron is disengaged, rotation of the lead-screw will move the carriage in one direction when nut *Z* is engaged with the chasing sleeve *Y*, and the rapid-return movement is obtained when nut *Z*₁ and sleeve *H* are in engagement. The dogs *T*₁ and *T*₂ determine the limits of travel by striking stop-pins on bracket *J*, which throws the handle *X* and rocker *Q* to the neutral position, in which position neither nut is in engagement.

If a right-hand thread is to be cut, the change-gears in the gear-box of the lathe are set for whatever pitch may be required, and the regular reverse handle *A* is thrown downward and left in that position. The attachment should be clamped tightly to the bed by means of clamp screw *L* at a point which will allow of the desired amount of travel. Handle *X* is placed in the neutral position and the two dogs *T*₁ and *T*₂, marked "R" (which signifies right-hand), are placed on shaft *I*. The latter is then connected with *X* by the taper pin *S*. The dogs are set by running the carriage by hand to the point where it is to stop, and then sliding the corresponding dog along shaft *I* until it engages the stop-pin. Assuming that the first cut is to be taken with the carriage at the tailstock end and that the lathe is in motion, throw handle *X* up to the cutting position (see Fig. 5), keeping the pressure on the handle until nut *Z* engages the thread on sleeve *Y*. The carriage will then travel along until the dog *T*₁ throws the rocker *Q* and handle *X* to the neutral position. After withdrawing the threading tool, handle *X* should be thrown down to the reverse position with a rapid movement, thus causing the carriage to return rapidly to the starting point; then dog *T*₂ throws nut *Z* out of engagement with sleeve *H*, and the carriage stops. This cycle of movements is repeated for each successive cut until the thread is completed. When cutting left-hand threads, the dogs marked "L" (left-hand) are substituted for those marked "R" and the regular reverse handle *A* is placed in the upper position. The operation of the attachment is the same for a left-hand thread as for one of the opposite hand, except that the quick-return movement is toward the lathe headstock. When using this attachment, the operating handle *X* should be thrown quickly from the neutral to the engaging positions, pressure being kept on the handle until the nuts are in engagement.

Regulating Pitch of Thread when Using Quick-threading Attachment

It is important to understand the relation between the pitch of the thread to be cut and the pitch for which the regular change-gear mechanism of the lathe is set when using the quick-threading attachment shown in Figs. 4 and 5. On Hendey lathes up to and including 20 inches swing, the lead-screw has 6 threads per inch, and, as previously mentioned, the chasing

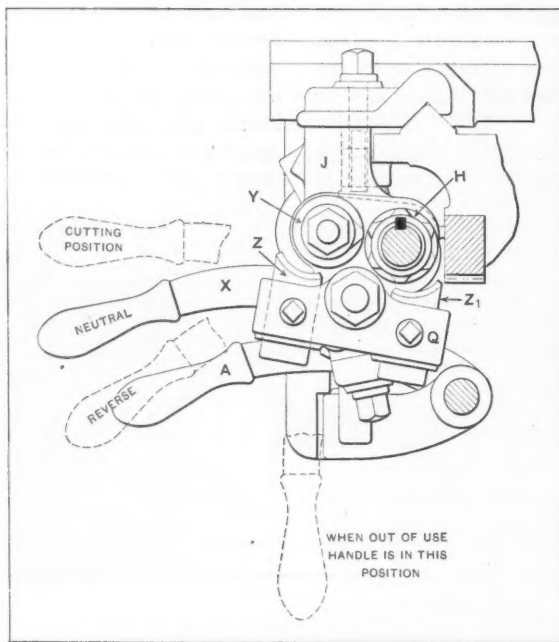


Fig. 5. End View of Quick-threading Attachment shown in Fig. 4

sleeve of the threading attachment revolves at the same speed as the lead-screw; therefore, it is evident that, when the lathe gear-box is set for 6 threads per inch, the pitch of the thread cut by the attachment will be the same as that of the chasing sleeve on the attachment. If the gear-box were set for 12 threads per inch, a thread of one-half the pitch of the chasing sleeve would be cut, and so on, it being possible to cut any number of threads per inch listed on the index plate of the gear-box, which is divisible by 6. For example, suppose that the chasing sleeve of the attachment has 4 threads per inch; then, with the gear-box handle set at 6 threads per inch, a 4-pitch thread will be cut; with the handle at 12, an 8-pitch thread; with the handle at 18, a 12-pitch thread; with the handle at 24, a 16-pitch thread; with the handle at 36, a 24-pitch thread, etc. When the gear-box handle is set at intermediate positions or for pitches not divisible by 6, the thread cannot be "picked up" again when the second cut is started, because the chasing sleeve is always in motion. When cutting threads which are finer than those on the chasing sleeve, it is evident that the lead-screw and attachment must rotate at a reduced speed, which reduces the speed of the return travel; therefore, it is advisable to use a chasing sleeve having a pitch as near as possible to the one that is to be cut.

Thread-cutting Attachment for Lathe of Manufacturing Type

An attachment for cutting screw threads rapidly on a lathe of the manufacturing type (see Fig. 6) is so arranged that the carriage is moved along the bed by the direct action of a short lead-screw and without the use of gearing between the lead-screw and the spindle. The lead-screw is in the form of an externally threaded sleeve and is mounted on an extension of the spindle. When a cut is being taken, the lead-screw is engaged by two segment-shaped nuts. One nut is shown at *C* and the other is on the opposite side of the lead-screw. These nuts, by traversing bracket *J* and the pull-rod *K*, transmit motion to the carriage.

In order to adjust the attachment, the carriage is located in the position it should occupy at the beginning of the cut. The right-hand carriage stop is then placed against it and fastened. The bracket *J* should be located next to the headstock and should be attached to pull-rod *K*, which, in turn, is secured to the carriage by means of a grip screw. With the carriage in this position, handwheel *A* is turned to the left, thus locating the two arms *B* in the position shown, which engages the nuts with the lead-screw. Stop *D* is next set so that finger *E* will contact with finger *F*. The wheel *A* is now turned to the right for disengaging the nuts from the lead-screw and the carriage is moved forward to the position it occupies at the end of the cut. After wheel *A* is turned to the right as far as it will go, or until the square corner of arm *B* comes into contact with the left-hand side of block *G*, trip-latch *H* is set so that it engages trip-finger *I*.

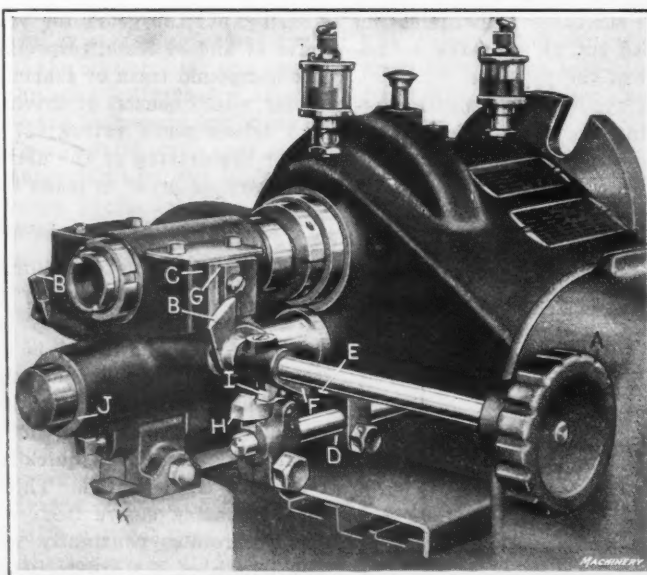


Fig. 6. Screw-cutting Attachment for Lathe of Manufacturing Type

When cutting a thread the carriage is located in the starting position by the stop at the right-hand side. When the tool has been fed in for taking a cut, wheel *A* is turned to the left, thus engaging the nuts and lead-screw. The carriage moves forward until the nuts are automatically disengaged by the engagement of finger *I* with latch *H*. The tool is then withdrawn and the carriage returned by hand to the starting position. This cycle of operations is repeated until the thread is finished. The manufacturing lathe to which this attachment is applied is made by the Porter-Cable Machine Co., Syracuse, N. Y.

Thread-chasing Attachment

The lathes of the Fox or monitor type, which are used so extensively in the manufacture of brass fittings, have a thread-chasing attachment that affords a rapid means of cutting screw threads. The chasing attachment shown on the universal turret lathe in Figs. 8 and 9 (built by the Acme Machine Tool Co., Cincinnati, Ohio) will serve to illustrate the important features common to attachments of this kind. The attachment has a round bar *A* extending along the rear of the bed. This bar is mounted in bearings so that it is free to move in an endwise direction. Attached to one end of the bar there is an arm *B* which carries the follower *G*. The follower has several arms or sections which are threaded like the segment of a nut. These segment-shaped ends have threads of different pitches to match the pitch of the thread on whatever leader *C* is being used. When the chasing attachment is in use, the follower is placed in engagement with this leader *C*, which is simply a short lead-screw and is connected through gearing with the machine spindle. As the leader rotates, an endwise movement is imparted to the chasing bar *A* and to the thread-chasing tool which is carried by a toolpost on slide *H*, which, in turn, is supported by arm *F* attached at the rear to bar *A*. The leader is sometimes applied directly to the spindle, in which case its pitch must coincide with the pitch of the thread to be cut. Ordinarily, however, it is mounted on a shaft and is geared to the spindle in the ratio of 2 to 1, the leader revolving at one-half the spindle speed. When the leader is driven through gearing, the relation between the pitch of its thread and the pitch of the thread on the work depends upon the gear ratio. In any case where gearing is used, the leader revolves slower than the spindle in order to increase its pitch and make the threads coarser and more durable. If the ratio of the gearing were 2 to 1, the pitch of the thread on the leader would be double the pitch of the thread to be cut.

The slide which carries the chasing tool is operated by crank *E*, which serves to adjust the tool in accordance with the diameter of the work. The slide is located for cutting threads on duplicate parts by a stop-screw *K*. The arm *F* has an extension which rests upon a swiveling plate *D* at the front

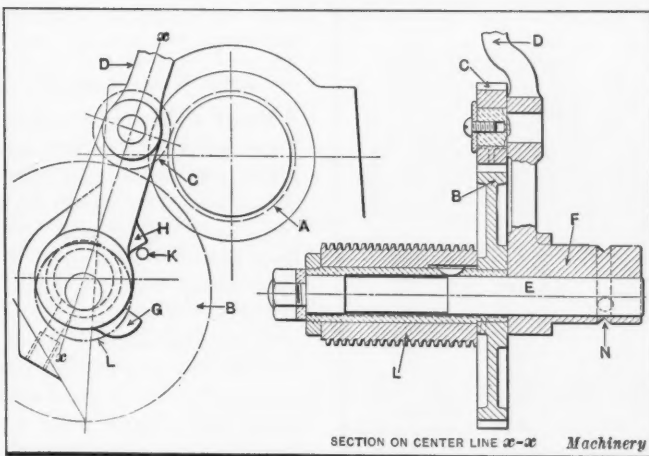


Fig. 7. Leader Driving and Reverse Mechanism

of the bed. The upper edge of this plate is in a horizontal position, except when cutting taper threads. When arm *F* is shifted by the handle *L* at the end of the extension, the chaser bar is turned in its bearings and the follower and leader are disengaged; at the same time the tool is withdrawn from the work. The tool-slide is prevented from swinging farther back than is necessary by a finger *N*, which engages a projection on the bed. The part to be threaded may either be held in some form of chuck, on a special arbor inserted in the

spindle, or between centers, the outer center being carried in a hole in the turret. The tool-rest is clamped along bar *A* at the rear, in whatever position is necessary for locating the tool relative to the part to be threaded.

Method of Using Thread-chasing Attachment

When an attachment of the type illustrated in Figs. 8 and 9 is in use, the tool or chaser, which is held in an inverted position, is traversed by the leader, until the end of the cut is reached; the follower is then disengaged from the leader and the tool returned for another cut, which is taken as soon as the tool is fed downward by handle *E*. These cuts may be taken rapidly and a thread finished in a surprisingly short time. The action of the chaser bar may be controlled entirely by hand or may be partly regulated by adjustable stops on bar *A* and a return spring. One method of using stops is as follows: When the chaser has moved forward the required distance, a stop on the bar makes contact with a fixed stop (which may be one of the bearings in which the shaft slides and oscillates), and the angular flanks of the leader thread force the follower out of engagement and cause the chaser or cutter to withdraw from the work. Then a coiled spring or weight acting on the bar causes it to return to the starting position, which is also regulated by an adjustable stop. This operation is repeated until the thread is finished. The method of using a stop on the machine shown in Figs. 8 and 9 is as follows: The stop *P* is set so that a spring (not shown) will return the chaser just beyond the end of the piece to be threaded, and the follower *G* is so located relative to the leader *C* that it runs off the thread of the leader when the required length of thread has been chased.

The followers of chasing attachments have teeth formed on them by means of a hob. This hob may be placed on the leader spindle temporarily, or cutting teeth may be formed at one end of the leader, thus combining the leader and hob in one unit. When there is a star-shaped follower having teeth of several different pitches (as shown at *G*, Fig. 9), the follower is, of course, turned to locate in the working position, whichever end corresponds to the pitch of the leader being used. The leaders for thread-chasing lathes should be made of tool steel (not necessarily hardened) and the followers of a fairly soft material, such as brass.

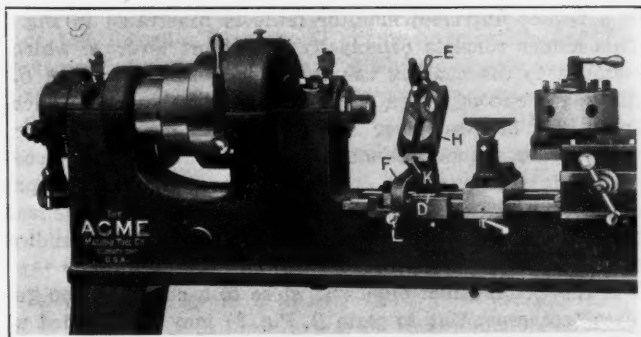


Fig. 8. Front View of Universal Turret or Monitor Lathe equipped with Thread-chasing Attachment

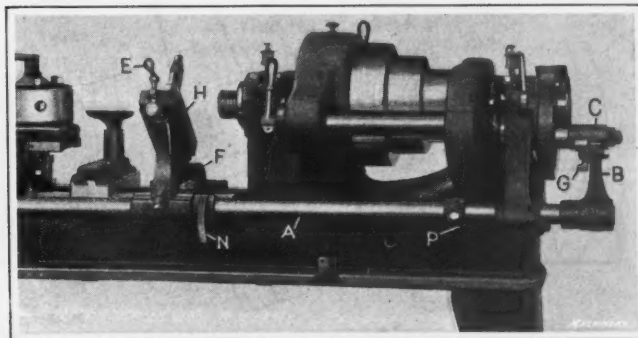


Fig. 9. Rear View of Universal Turret Lathe equipped with Thread-chasing Attachment

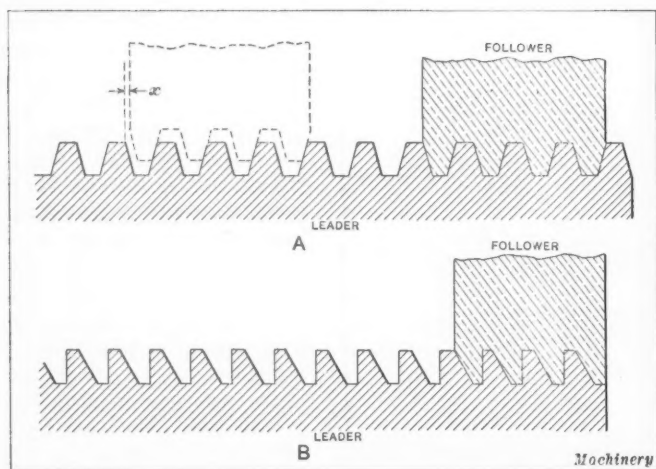


Fig. 10. (A) Action of Follower when using Rigid Follower Arm while chasing Taper Threads. (B) Form of Leader Thread intended to prevent Loss of Pitch when chasing Taper Threads

Cutting Left-hand Threads with Chasing Attachment

The gearing connecting the spindle and leader of a thread-chasing attachment of the Fox type is commonly provided with an intermediate or idler gear which can be engaged in order to permit cutting left-hand threads. This idler gear is mounted on a swinging plate, and when cutting right-hand threads, the drive is direct from the spindle gear to the gear which drives the leader. When it is necessary to cut left-hand threads, the idler is pushed over in mesh with the spindle gear, and at the same time the leader is disengaged from the gear on the spindle, so that the motion is transmitted through the idler. This reverses the motion of the leader and the movement of the chaser on the cutting stroke. It is the practice in some brass-working shops to reverse the lathe spindle for chasing left-hand threads so that the leader will continue to revolve in the same direction and the chaser will move toward the headstock of the machine when cutting a left-hand thread, the same as for a right-hand thread.

The leader driving and reversing mechanism of the universal monitor lathe built by the Dreses Machine Tool Co., Cincinnati, Ohio, is shown in Fig. 7. Gear A is on the main spindle and gear B drives the leader. For chasing right-hand screw threads, motion is transmitted directly from gear A to gear B, but for left-hand threads lever D is shifted to the position shown in the illustration. The drive is then through gears A, C and B. Lever D with its boss F swivels in a bearing formed in the headstock and is held in place by a set-screw and plug engaging the annular groove N. Lever D also carries the small intermediate gear C. Stud E, which supports the leader L and the large gear B, is located eccentrically in boss F, so that by swinging lever D in one direction or the other, the direct drive or the drive through the intermediate gear is obtained. The lugs G and H on lever D en-

gage a fixed pin K attached to the headstock, which limits the movement of the lever and brings the gears into proper mesh.

Application of Chasing Attachment to Tapering Work

When a chasing attachment of the type illustrated in Figs. 8 and 9 is applied to the cutting of tapering screw threads, the plate D is tilted at an angle, so that as arm F is traversed along the plate, it will be elevated, thus causing the tool to cut a tapering thread. The inclination of this plate depends upon the relative lengths of the two arms of the chasing lever, the distance from the cutting teeth of the chaser to the center of bar A representing one arm and the distance from plate D to bar A representing the other arm.

If the arm B to which the follower is attached were rigidly connected to bar A when chasing a tapered thread, the follower would move away from the leader as the chasing tool and arm F were elevated by the inclined plate D, while traversing from the small to the large end of the tapering part being threaded. Any such movement of the follower relative to the leader would cause the chaser bar to lag behind and result in a loss in pitch, as illustrated diagrammatically at A in Fig. 10. The follower, which is shown in full mesh at the starting point, would gradually move outward on the angular side of the leader thread and there would be a loss in pitch, as indicated by dimension x. For many classes of brass work, the error in pitch resulting from this action of the follower might be of little consequence, especially when mating parts are chased in the same way. The chasing attachment shown in Figs. 8 and 9, and many other chasing attachments now in use, have a flexible or yielding follower arm which makes it possible to chase all taper threads satisfactorily and without loss of pitch.

In order to overcome the loss of pitch due to the relative movement between a rigid follower and a parallel or straight leader, the form of leader thread illustrated at B in Fig. 10 has been employed. As will be seen, one side of the thread is perpendicular to the axis of the leader. One of the disadvantages of this form of thread is that the bearing between the follower teeth and the leader thread decreases as the follower moves outward, due to the difference between the helix angles of the surfaces in contact. In some cases this difficulty has been partly overcome by allowing the follower to swivel on a stud located at right angles to the axis of the leader.

Instead of using parallel leaders for chasing taper threads, taper leaders have been employed in conjunction with an inclined plate for guiding the chasing arm. When using a taper leader, it is necessary to consider the bearing contact with the follower, which cannot be made to fit the leader thread at all points. For instance, if the follower is fitted to the small end of the leader, the angle of its teeth will be greater than if it were made to fit the large end of the leader. The contact on the driving side will be at one point only on each thread or tooth, except at the small end. If the follower is fitted to the large end of a tapering leader, a better bearing will be obtained, although, in any case, a relatively small amount of follower surface will be in contact with the leader.

Flexible or Spring-supported Follower Arm for Chasing Taper Threads

The difficulties previously referred to in connection with taper work have been overcome by using a flexible or spring-supported follower arm. The yielding follower arm or holder of a Dreses universal monitor lathe is illustrated in Fig. 11. This holder consists principally of a short lever A, which is clamped to the chasing bar B, and a yoke-shaped arm C, to the upper end of which the star-shaped follower is attached. Interposed between lever A and arm C is a spiral spring D, which bears against one side of lever A and rests in a pocket formed in arm C. When chasing a tapered thread, this spring connection holds the follower into engagement with the leader while the chasing tool travels from the large to the small end of the tapering screw thread.

If the chasing tool must run close to a shoulder, the guide plate (corresponding to plate D, Fig. 8) may be provided with a rather abrupt tapering shoulder for elevating the chasing tool quickly at the end of the cut.

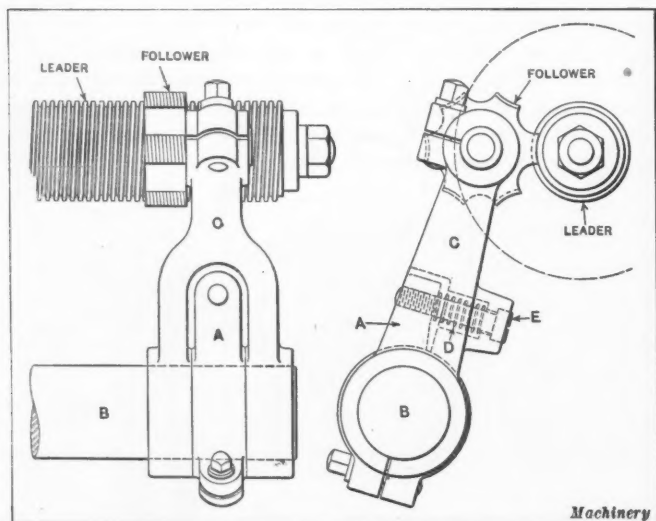


Fig. 11. Flexible or Yielding Follower Arm for holding Follower in Contact with Straight Leader when chasing Taper Threads

Thread-cutting Mechanism of Gisholt Turret Lathe

While most thread cutting in the turret lathe is done by means of taps or dies, special sizes or pitches are often required which can be cut to better advantage by using either a single-point tool or a chaser. The Gisholt turret lathe is so arranged that the carriage can be traversed by the lead-screw when a single-point tool or chaser is to be used. The lead-screw is driven through change-gears which provide for cutting thirty-two different leads or pitches, ranging from 4 to 56 threads per inch. These same gears also furnish sixty-four feed changes, the necessary reduction of movement for feeding being obtained by shifting a pull-pin which changes the ratio of the gearing through which motion is transmitted from the change-gears to the lead-screw.

The arrangement of the mechanism on the carriage which makes it possible to readily "catch the thread" each time a cut is taken is shown in Fig. 12. The view at A illustrates the old type, and that at B, the new type. These two designs differ somewhat, but are the same in principle. The lead-screw nut has a number of equally spaced notches in flange *f*, and when the carriage is being traversed by the lead-screw, the end of pull-pin *p* engages one of these notches. When the tool reaches the end of its cut, pull-pin *p* is withdrawn and the carriage is returned by hand for taking another cut. The different notches in the lead-screw nut serve the same purpose as the graduated thread indicator on an ordinary engine lathe in that they are used for engaging the carriage and lead-screw at the right time, so that the tool will follow the original cut or thread groove. The number of notches in any lead-screw nut depends upon the pitch of the lead-screw on that particular machine. The lead-screw nuts with pitches of 3, 4 and 5 inches have notches so located that they represent inches of carriage travel, there being three notches in the lead-screw nut of 3-inch pitch, four notches in the nut of 4-inch pitch, and so on. The lead-screw nuts having pitches of $3\frac{1}{2}$ and $4\frac{1}{2}$ inches, which are found on two sizes of Gisholt turret lathes, have notches representing $\frac{1}{2}$ inch of carriage travel.

When cutting threads of even pitch, such as four, six or eight threads per inch, the pull-pin *p* may be engaged with any notch on the lead-screw nut, regardless of the pitch of the lead-screw, and the tool will follow the original cut. The reason why any notch may be engaged when the number of threads per inch is even is illustrated by the diagram A, Fig. 13, which shows a screw having four threads per inch. Thus, if the movement of the tool is 1 inch, as represented by positions *a* and *b*, or any whole number of inches, it will still remain in alignment with the thread groove. The alignment would also be maintained for half-inch movements, as indicated by positions *a* and *c*. If there were an odd number of threads per inch, as indicated at B, it would be necessary to engage the pull-pin with notches representing an inch of carriage travel, as illustrated by positions *d* and *e*. This requires two notches, or any number evenly divided by 2 on those machines where one notch represents one-half inch of carriage travel, whereas on the other machines any notch will catch the thread. A movement equivalent to $\frac{1}{2}$ inch, $1\frac{1}{2}$ inch, etc., would locate the tool on line with the top of the thread, as illustrated at *f*. If there were $5\frac{1}{2}$ threads per inch to be cut, the pull-pin should be engaged only with notches representing two inches of travel, or 11 threads on the screw, because a movement of one inch would align the tool with the top of the thread. Diagram C shows a screw having $5\frac{1}{4}$ threads per inch. In this case, the movement should be equivalent to 4 inches, or 23 threads. If the notches represent inches of carriage travel, the engagement of the pull-pin with the lead-screw nut should be at points either four notches apart or any number evenly divided by 4. On the other hand, if the notches represent half inches of carriage travel, engagement at points eight notches apart, or any number evenly divided by 8, will catch the full thread. The various positions of the tools in diagram C clearly show why the movement must be equivalent to four inches, or some multiple of 4, in order to again locate the tool in alignment with the thread groove.

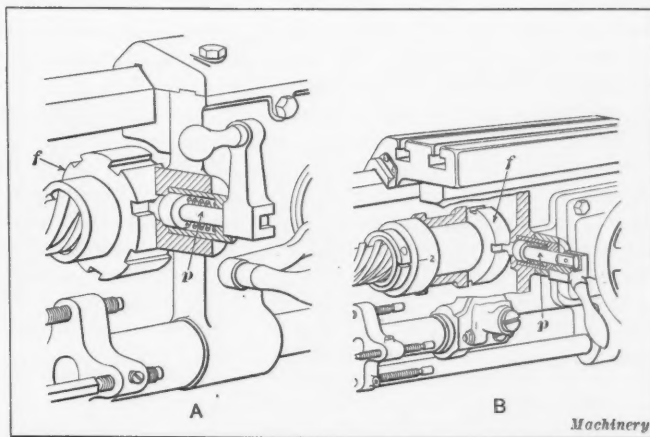


Fig. 12. Thread-cutting Mechanism of Gisholt Turret Lathe

Thread-chasing Attachment of Hartness Flat Turret Lathe

The screw-cutting or screw-chasing attachment shown in Fig. 14 is applied to the Hartness flat turret lathe, built by the Jones & Lamson Machine Co., Springfield, Vt. This attachment is semi-automatic in operation, the cutter or chaser advancing and returning automatically while the operator regulates the depth of cut by feeding the cross-sliding headstock the required amount for each stroke of the thread-chasing tool. The attachment is driven from the bevel gear A on the main spindle through spiral gears and spline shaft B; this shaft transmits motion through bevel gears C and D to vertical shaft E, the lower end of which carries a spiral gear F that meshes with spiral gear G, keyed to the special lead-screw H. The cutter-bar J has a threaded plug or sectional nut K engaging the lead-screw. When the tool has been fed forward the required amount, the adjustable collar L on the extension end of the lead-screw strikes plug M with its projecting end, thus rocking shaft N and allowing nut K to drop down on a flat part of the shaft and out of engagement with the lead-screw. At the same time, the rocking of shaft N, through the eccentric pin O, withdraws the tool from the work. On the lower end of shaft E there is a spur gear R driven by friction resulting from the pressure of spring S. This spur gear is constantly in engagement with rack teeth cut on the cutter-bar J. As soon as nut K is withdrawn, the cutter-bar is returned rapidly by the rack and pinion motion until a pin in collar T engages pin U, thus again turning shaft N to its former position, which reengages nut K with the lead-screw H, and then the cutting stroke is repeated. The small lever W may be used for disengaging the nut and withdrawing the tool by hand. With this arrangement, the main spindle ro-

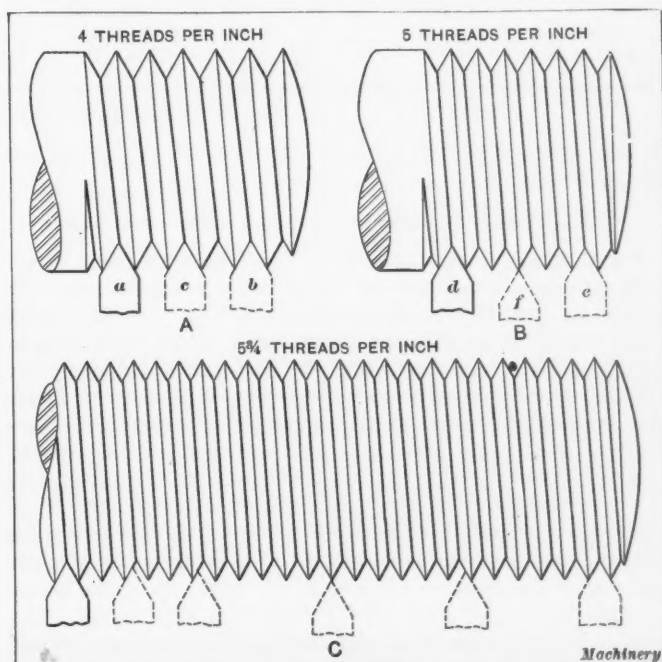


Fig. 13. Relation between Position of Tool and Screw Threads having Even, Odd, and Fractional Numbers of Threads per Inch

tates continuously in one direction. A separate lead-screw and nut is required for each different pitch, which must correspond to the pitch on the work. For taper threading operations the attachment is swiveled on its base. The chaser type of cutter, or one having several teeth, is used for U. S. standard threads, V-threads and Whitworth threads, but single-point cutters are recommended for square and Acme threads, as well as for all threads that must extend close to a shoulder. The connections at both the headstock and turret end swivel about vertical axes and the spline transmission shaft *B* slides through the headstock connection, so that lateral feeding movements of the headstock or the indexing of the turret does not interfere with the connection to the thread-chasing attachment. This attachment is adapted for internal and external thread-

The controlling lever is arranged to disengage automatically at the end of a cut. In order to chase left-hand threads with this attachment, it is simply necessary to shift the feed reverse lever on the gear-box at the front of the headstock.

Attachment for Cutting Threads on Drilling Machine

A drilling machine is sometimes used for cutting internal threads with a single-point tool when the part will not swing in the lathe and the use of a tap is not practicable. A lead-screw of whatever length may be needed is attached to the end of the cutter-bar, or the latter is extended to form a lead-screw as shown at *A*, Fig. 17. This lead-screw engages some form of nut that is bolted to the baseplate of the machine. The thread on the lead-screw corresponds, as to lead, with

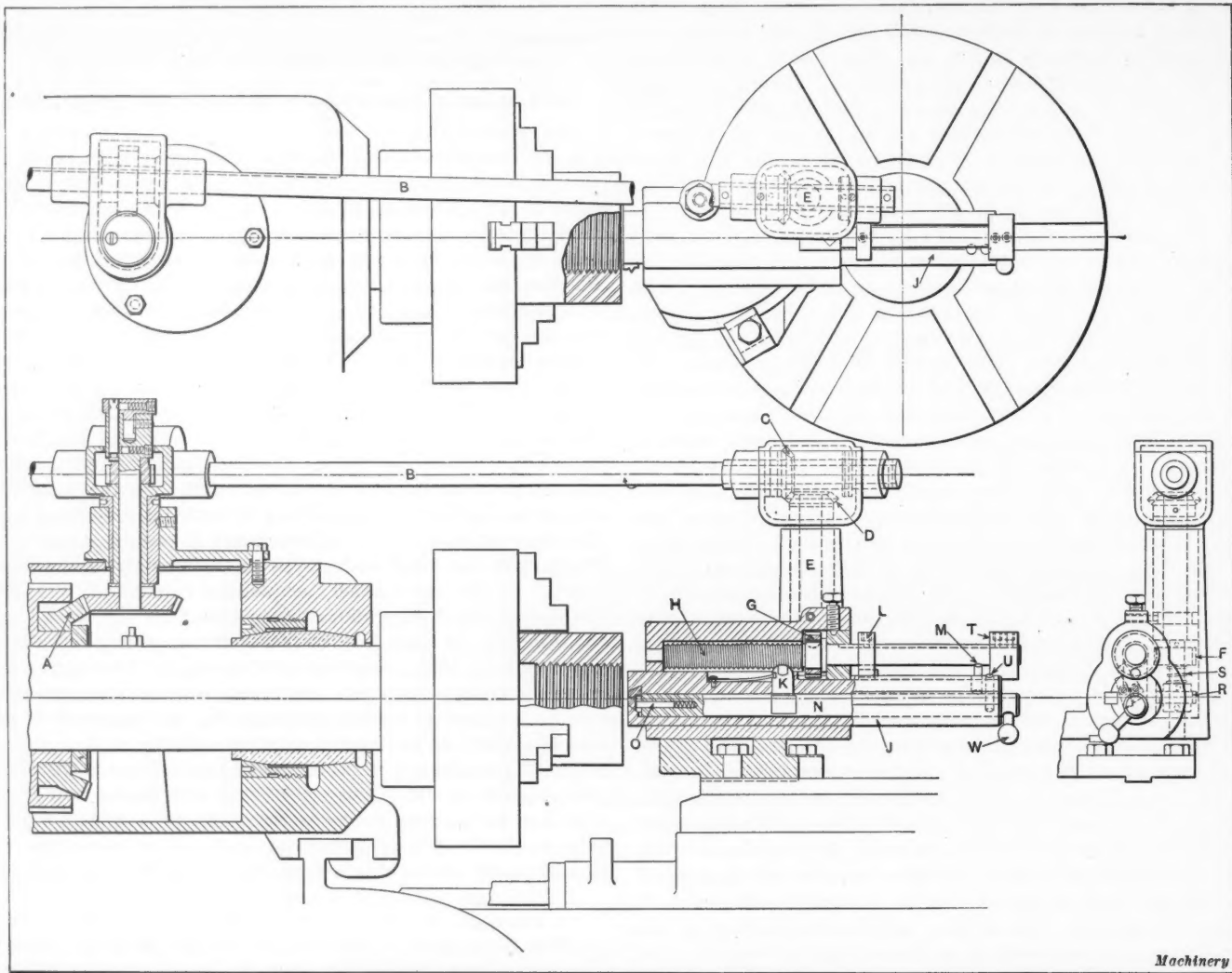


Fig. 14. Thread-chasing Attachment of Hartness Flat Turret Lathe

cutting operations. It is shown in Fig. 15 cutting an external thread.

Thread-chasing Attachment of Acme Flat Turret Lathe

The thread-chasing attachment of an Acme flat turret lathe, built by the Acme Machine Tool Co., Cincinnati, Ohio, is applied to the machine illustrated in Fig. 16. This chasing attachment may be used for either right- or left-hand threads on internal and external work. It is intended especially for cutting threads on parts which are either too large in diameter or required in too small a quantity to warrant the purchase of special taps and dies. An example of external thread cutting is shown in this particular illustration. A single-point cutter is carried by a 2-inch bar, which is rigidly held in a holder clamped onto the flat turret. The action of the carriage when cutting a thread is controlled by a leader shown on the feed-rod of the machine. The pitch of the thread which is cut corresponds to the pitch of the thread on this leader. The brass follower which engages the leader is moved into or out of engagement by the hand-lever shown. This lever is pivoted in a bracket which is bolted to the end of the carriage apron.

the thread to be cut, and, as the spindle revolves, the cutter forms a thread, as it is drawn down through the work by the direct action of the lead-screw. The spindle may be returned to the starting position by reversing it, assuming that the machine has a tapping attachment or other means for reversing the rotation. When performing an operation of this kind, the drill press spindle must be free to move vertically. With a makeshift arrangement of this kind intended for a special operation, the cutter would not require a special device for feeding it outward, as it could be reset for each cut without much trouble.

Thread Cutting on Vertical Boring Mill with Single-point Tool

The vertical boring mill is used quite frequently for cutting screw threads in order to finish a part complete at one setting of the work and avoid a second operation. Taps are often used for threading holes of small or medium size, but occasionally it is necessary to use either a single-point tool or a chaser for cutting a thread which is not standard or which is too large in diameter for tapping. When a single-point tool or chaser is employed, the cutter-bar must be traversed for

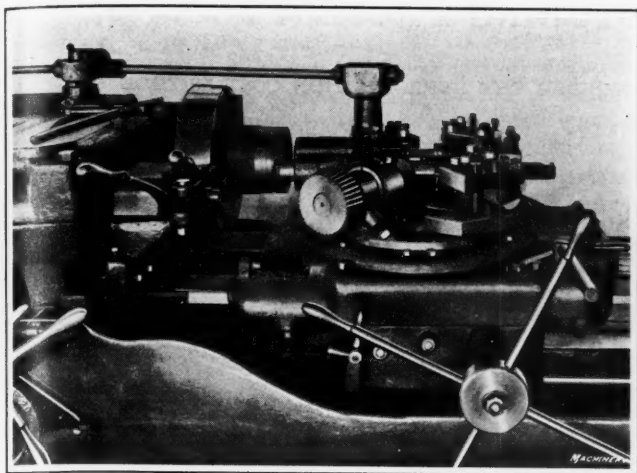


Fig. 15. Thread-chasing Attachment shown in Fig. 14 cutting an External Thread

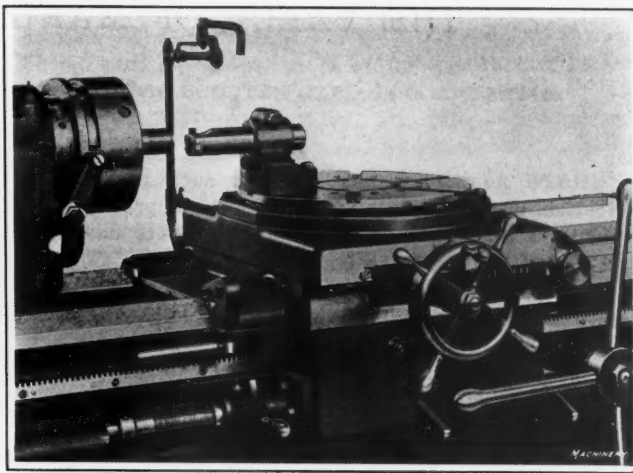


Fig. 16. Flat Turret Lathe built by Acme Machine Tool Co. equipped with Thread-chasing Attachment

controlling the lead of the thread. This traversing movement is usually obtained by means of special change-gears, which are inserted in the feeding mechanism at one end of the cross-rail. The change-gears are used to transmit motion to the cross-rail feed shaft, and they are selected with reference to the lead of the thread to be cut, the same as the change-gears of a lathe. Whatever special equipment may be needed for holding such gearing in position is supplied by most boring mill manufacturers. This is a simple and inexpensive arrangement, as motion is transmitted to the regular down-feed mechanism of the boring-bar or tool-slide through these extra gears. Some boring mill manufacturers supply this type of thread-chasing attachment for ordinary threading operations, such as the cutting of threads in large pipe flanges, etc., but for more accurate work a special lead-screw is used to control the motion of the tool-slide. A different lead-screw may be used for each pitch or lead of thread that is cut, or variations may be obtained by driving a lead-screw through change-gearing, the same as on an engine lathe.

A simple method of applying a lead-screw to a vertical boring mill is shown by diagram B, Fig. 17. This is not recommended for general application, but has been used to advantage when a machine was not equipped with a regular thread-cutting mechanism and it was particularly desirable to cut the thread in the boring mill. Some form of lead-screw is attached to the end of the tool-slide, and a nut which engages the lead-screw is fastened in the central hole in the machine table. The thread tool is held preferably in a holder provided with some simple means of adjusting it when taking successive cuts. As the machine table revolves, the lead-screw and tool-slide, which should be free to move vertically, are drawn downward, thus cutting a thread corresponding to the pitch of the lead-screw.

One design of vertical boring mill has a central boring-bar with an independent rotary drive. With such a machine, a lead-screw for threading operations may be applied directly to the upper end of the bar. The split nut for engaging the lead-screw may be mounted on a stationary arm or yoke, which, in turn, is held in position by shafts or studs far enough above the end of the bar to permit moving the latter to its highest vertical position. The nuts are opened or closed by a vertical shaft having a lever at its lower end within reach of the operator. With this arrangement, the boring-bar revolves and the work remains stationary while the

thread is being cut. If much thread cutting is to be done with an attachment of this kind, provision should be made for adjusting the tool radially by applying some form of independent slide at the end of the boring-bar. Threading attachments of this kind are not in common use, because comparatively few boring mills are equipped with an auxiliary boring-bar, such as is found on some of the larger machines for performing high-speed boring independently of the table rotation.

* * *

REPORTS BY EMPLOYERS ON WAR INCOME TAX

Employers of labor in any capacity are required by the War Revenue Act of October 3, 1917, to report to the Internal Revenue Collector of their district the names and addresses of all employees, past and present, to whom they have paid a wage or salary of \$800 or more since January 1, 1917. The object of this provision of the law for collecting information at the source is to give the Revenue Department as absolute a check as possible on all persons subject to the war income tax. It should be understood that the expression "employee" means, in this case, all persons employed or who have rendered service in any capacity. Attention should also be called to the fact that employees who are not now in the employ of a firm must be reported if, during 1917, at any time, they were employed and received a total salary, wage, fee or remuneration of \$800 or more.

* * *

BLACK FINISH ON STEEL

A good black finish can be produced on steel by the following method: Prepare a saturated solution of caustic soda and add a small amount of saltpeter, say a small handful to a five-gallon solution. Boil the solution for a short time and allow it to cool over night. The clear liquid should only be used, and this should be brought to the boiling point in an iron kettle. The articles should be wired as for plating and immersed in the blackening solution. The articles will take on a gray color at once with black underneath and should be left in the solution until the gray finish disappears and a beautiful black remains. Rinse the articles in cold water, dry in sawdust and oil with linseed oil, and wipe clean. The resulting finish will be a fine blue black that wears well, and is suitable for shears, razors, etc.—*Metal Industry*

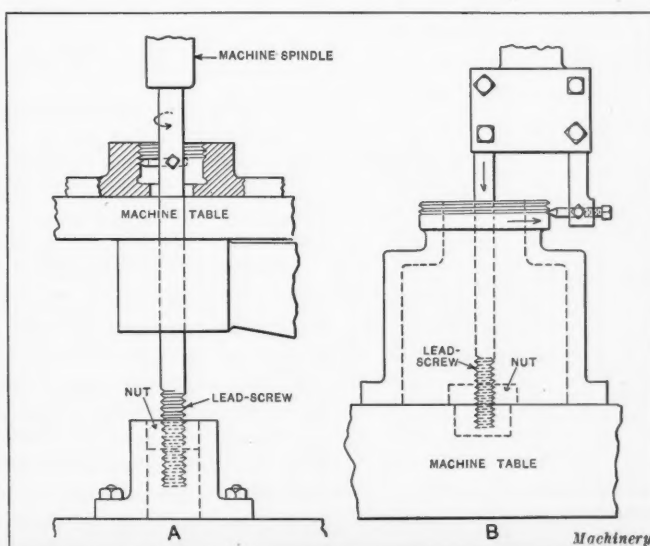


Fig. 17. (A) Method of cutting Threads on Drilling Machine with Single-point Tool. (B) Makeshift Arrangement for cutting Threads on Vertical Boring Mill

THE VALUE OF MANUFACTURING PROPERTY¹

DIFFERENT APPRAISAL METHODS AND ITEMS THAT COMPRISE THE REPRODUCTION COST METHOD

BY CHARLES W. MCKAY²

PERHAPS no subject has attracted such universal attention, during the past decade, as the appraisal of public utility plants. These appraisements have been subjected to the most searching scrutiny by the legal, engineering, and accounting professions, for public-utility corporations are almost universally subject to regulatory measures inaugurated by federal or state public-utility commissions. But in the industrial field, appraisal work has been confined largely to the valuation of the purely physical assets of manufacturing companies. Although it is only natural that progress in the public-utility field should be reflected, to some extent at least, in what may be termed the private-utility field, the established precedent in industrial-plant appraisal has been largely confined to a consideration of the purely physical assets. In other words, industrial appraisers have depended largely on the appraisal of the so-called "inventoriable property," or that part of the property which can be actually seen and counted in the field. Public-utility appraisers, on the other hand, have long recognized the fact that many elements of cost enter into the appraisal of the property of a utility corporation besides the cost of the inventoriable property. These costs include what are usually termed the "collateral costs"; they may be divided into the four general classes: Cost of general and legal organizations; cost of engineering and general supervision during construction; taxes and insurance on property during the construction period; interest on investment during construction.

Every student of industrial problems realizes that the value of the purely tangible, or inventoriable, property is only one of the elements component to the total value of industrial property. In a paper read before the American Society of Mechanical Engineers, Professor Gantt says: "The following factors are important elements in determining the value of an industrial property: Cost of product, capacity of plant, part of plant operated, and expense of maintenance of idle portion." Or, stated in a different way, the reproduction cost of the tangible and the intangible property, the depreciated value of the property, the cost of producing and marketing the plant output, and the production capacity of the plant are all factors that deserve the most careful consideration in attempting to place a value upon the property of an industrial organization.

The accompanying summary, which is taken from a recent reproduction-cost appraisal, will convey a general idea of the relation of the so-called "collateral costs" to the other elements component to the total value of the physical property of an industrial company. It will be noted that besides the cost of the inventoriable property there have been included in the direct construction costs, omissions and contingencies, purchasing expense during construction, and tools and tool expense during construction.

Summary of Physical Property

Direct construction costs—	Reproduction Cost	Present Value
Land		
Buildings		
Machine tools—lathes, boring mills, etc....		
Auxiliary equipment—chucks, etc.....		
Electrical equipment—motors, rheostats, etc.		
Belting		
Shafting		
Small tools and dies.....		
Patterns and drawings.....		
Stock and supplies.....		
Furniture and fixtures.....		
Total inventoriable property—		
Omissions and contingencies.....		
Purchasing expense during construction....		
Tools and tool expense during construction		
Total direct construction costs.....		

Collateral construction costs—

	Reproduction Cost	Present Value
General and legal expense during construction		
Engineering and general supervision during construction		
Taxes and insurance during construction...		
Interest on investment during construction		
Total collateral construction costs.....		
Total cost physical property.....		

Reproduction Method of Appraisal

To one unfamiliar with the foregoing method of appraisal, the collateral construction costs and the allowances for omissions, contingencies, etc., may seem to be an effort to inflate property values. But after a little consideration even the most practical industrial men will agree that these items are a real part of the cost of constructing any industrial property. While in the reproduction-cost method all these items will be estimated by a method necessarily based somewhat upon assumptions, if the actual cost of original construction could be ascertained it would be found that actual expenditures had been made for just such items as those included in these items. The reproduction method was developed by those who were seeking for an accurate determination of property values as a basis for cost studies and the determination of an equitable sales price for the product. The book values did not always represent real values; nor could the latter be determined by finding the actual cash outlay, for many industrial companies were not very particular as to the segregation of operating and capital expenditures. When operating employees were used for the installation and erection of new machinery, the cost of labor was frequently charged to operation and not to new construction. As a result, the cost shown on the books included only the cost of the machine and possibly the freight; no allowance was made for the labor costs involved in building the foundations and erecting the machinery.

Relation between Cost of Inventoriable Property and Collateral Costs

The accompanying summary shows that the inventoriable property includes only the actual visible assets as inventoried in the field, and subsequently priced at current market prices, including both cost of material and labor of installation. The close connection between the collateral costs and the cost of the inventoriable property may be made clearer by making the complete appraisal of one item of inventoriable property, say a Corliss engine. The reproduction cost of this engine, as included in the appraisal of the strictly physical property, will be computed somewhat as follows:

Cost of engine f.o.b. point of manufacture.....\$
Cost of freight from point of manufacture to plant location
Cost of transporting and erecting engine on foundations
Cost of material and labor of constructing foundations
Cost of direct supervision, actual cost of time of foreman who superintends erecting and erection operations
Total reproduction cost of engine.....\$

It is at this point that appraisers of the old school of industrial evaluation stop; they further contend that this cost represents the total reproduction cost of the property under consideration. But, before the engine is bought the purchasing agent, the designing engineer, and possibly the plant executives will decide upon the type of engine required to perform the service in the plant under consideration. Subsequently, various engine companies will submit competitive bids from which the purchasing agent, together with his immediate superiors, will decide which is the most favorable and award the contract. There are two elements of expense involved in this operation, purchasing and engineering.

¹For previous articles on this and allied subjects published in MACHINERY, see "Productive Capacity a Measure of Value of an Industrial Plant," April, 1917; and "The Valuation of Machine Tools," May, 1915.

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After the engine has been received, the expense of installation may materially exceed any cost estimate made by an appraisal engineer in evaluating the property. For instance, in excavating for the foundations, quicksand or some other unstable soil may be encountered, but an estimate made by an appraisal engineer who does not know of the unusual sub-surface conditions will be based entirely on normal conditions; hence, the item of contingencies. In the construction of every industrial plant certain unusual conditions are encountered so that conservative engineering practice is to make an allowance of from 1 to 2 per cent of the cost of reproduction for contingencies.

Again in the installation and erection of an engine, certain tools, like hand tools and pneumatic tools, may be required. While, considered alone, this item is of relatively small importance, in the erection of a large industrial property it may amount to an appreciable sum.

General and Legal Expense

The item general and legal expense during construction includes the general expense of the executive and administrative organization up to the time the property becomes an operating entity. This item includes the salaries and expenses of the general executives, bookkeepers, timekeepers, and pay-masters, and the retainer for legal counsel required for the organization of the company. Any practical industrial executive will realize that the construction of a new industrial property necessarily involves an appreciable expenditure for engineering and general supervision during construction. Plans must be prepared for the general lay-out of the buildings, for the transportation facilities, and for the distribution of the machinery in the buildings themselves. Many industrial organizations retain the engineer employed in a consulting capacity prior to the construction period throughout the entire construction period to supervise the work of building the plant and, in many cases, as a plant engineer for the operating company. Nevertheless, the salary and expenses of the chief engineer and his assistants, up to the time the property actually begins to operate, is a capital and not an administrative charge.

Taxes and Insurance During Construction

Taxes and insurance on real estate and equipment up to the time the plant actually begins to operate are unquestionably charges against the capital account. Both taxes and insurance may be computed on a percentage basis, by applying a predetermined percentage to the reproduction cost of the taxable and insurable property, or they may be determined, perhaps a little more accurately, by analyzing the taxable and insurable items and estimating the actual costs of taxes and insurance by applying prevalent insurance and tax rates.

Interest During Construction

The construction of an industrial property costs money in two ways: The real estate, machinery, and equipment represent an appreciable monetary outlay and the money used for the purchase of land, construction of buildings and construction and installation of machinery and equipment must be paid for at the current market rate for borrowed money. Interest on the investment in an industrial property, up to the time the plant begins to operate, is undeniably a part of the construction cost.

At the beginning of the construction period there are no tangible assets that can be mortgaged to raise money. The promoters, therefore, must borrow such funds as they may require for immediate use on short-term notes. Subsequently, as tangible assets are brought into being, these short-term notes may be replaced by permanent mortgages or bonds on the property. In a similar manner, additional funds for carrying on the project may be raised.

The cost of interest during construction may be computed by estimating the probable length of time that interest on the investment in the various portions of the plant, such as buildings, machinery, equipment, etc., will have to be carried as a capital rather than an operating expenditure and by applying prevalent interest rates to the various sums in-

involved for the time periods estimated. A simpler way, though, consists of estimating the average investment tied up in plant construction during the entire construction period and applying thereto the interest rate prevalent at the time of the appraisal. The total to which this rate is applied will, of course, include all the direct and collateral construction costs.

Conclusion

From the foregoing it will be apparent that there are many costs involved in the construction of a modern industrial property besides the actual cost of the inventoriable property. While these costs are really a part of the cost of the inventoriable property, for obvious reasons they cannot be included directly in the unit costs as generally applied to the inventory in determining the reproduction cost of a plant.

Many industrial executives deceive themselves by assuming that the inventory and appraisal of that part of the property that can actually be seen and counted in the field represents the entire investment in physical property. They entirely overlook the fact that many other elements of cost are really part and parcel of the cost, but cannot be included in the unit costs as applied to the inventoriable property. Undoubtedly there may be reasons why some industrial executives wish to limit the value of the physical property carried on the books, but on the other hand industrial executives are constantly confronted with problems that can be solved only by one having an accurate knowledge of total plant investment, as represented by the reproduction cost, and by the present value of physical property, as represented by reproduction cost less accrued depreciation.

Among the possible uses of total reproduction cost, including collateral costs, are:

1. The determination of total investment as a factor to be considered in the determination of a proper sales price for the plant output.
2. The determination of the total value of the physical property as a basis for capitalization; that is, the issuance of securities.
3. The determination of total value, both on a reproduction cost and a reproduction cost less depreciation basis, for the purpose of ascertaining the real value of the physical property in the event of a proposed sale or in the event of a proposed consolidation of the property under consideration with other similar properties.
4. The determination of invested capital for computing war profit taxes.

Whether or not industrial corporations deem it advisable to include all these elements of collateral cost in the value of the property as carried on the books, any student of industrial problems will realize that it is most important to have a clear and complete record of total physical property value available for ready reference in solving such problems as those just enumerated.

* * *

ENGINEERING STUDENTS EXEMPT FROM DRAFT

The order of the secretary of war exempting engineering students from the selective draft for military service is a step that should have been taken immediately at the beginning of the war, but it is well that it has been taken as soon as it has. The exemption privilege is limited to those students to whom the engineering school issues a certificate, properly attested by the president of the school, reading as follows:

"I hereby certify that is a regular student of the class in good standing, as a candidate for an engineering degree at and that in the judgment of the faculty of this school, based upon his academic record, supplemented by his relations with fellow students and by observation of his instructors, he may fairly be regarded as deserving a place in the first third qualitatively of the young men graduating from this institution during the past ten years.

Hence, it is evident that the mere attendance at an engineering school does not exempt a student from being drafted for military service; the regulations governing the exemption require also that his record as regards his engineering studies be of a high character.

TOOLING A FOREIGN CAR IN AMERICA—2

TOOLING THE REAR AXLE HOUSING

BY THOMAS ORCHARD¹

IN this car, the rear axle housing, which, with the operations required, is shown on page 410 in the January number, is made in two parts. As most of the operations are performed with these parts assembled, it is necessary first to mill the surfaces of the joint and then drill the eight holes in each flange, reaming two for locating points in order that the assembling can be done as quickly as possible. The drill jig used for this purpose is similar to the one described in the preceding installment, but a different method of indexing is employed.

The fixture, shown in Fig. 1, consists of a plate, on each end of which are two wheels *A*. In order that these wheels

jig is removed and the work set on the finished pad and moved to the left until the flange comes against the two stops, which may be adjusted to suit the run of the castings. The work is next squared up by screwing in the clamp at the right-hand end of the work. After this has been done, the top clamp is replaced and the set-screw brought down against the boss on the top of the housing. The three sliding clamps are then brought into place and hold the work down at their respective locations against the flange.

The fixture may now be indexed 180 degrees in order to place the work in the proper position for drilling. The method of indexing is very simple. Lugs *E* and *F* are cast on one support and the outside of one wheel, respectively. Each lug has two adjustable stops. The indexing is practically done by gravity, as the weight of the work is on center, in both the loading and the drilling position. As a result, as soon as the operator starts to index the jig, the weight of the work will itself turn the wheels *A* until the stop *G* rests against the stop *H*, thus placing the jig in the drilling position. The set-screw in the top of the support should then be tightened against the shaft so that it cannot move while the drilling is being performed. After the jig is

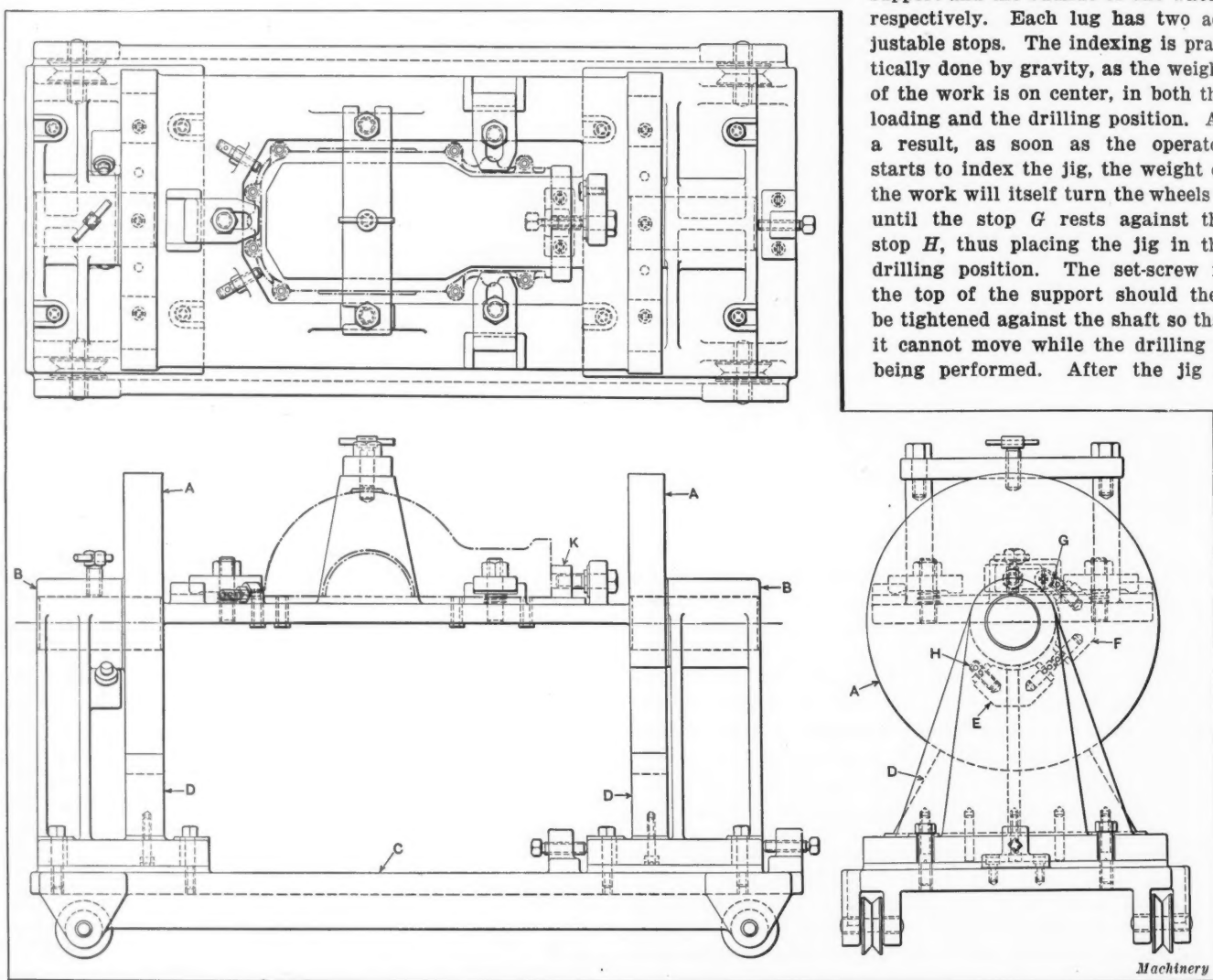


Fig. 1. Trunnion Jig for drilling Flange Holes

may rotate, steel shafts are pressed in them but are a running fit in the supports *B* at each end of the fixture. These supports are made of cast iron and are, in turn, tongued and bolted to a base *C* on which the entire fixture rests. The wheels ride on cast-iron shoes *D*, which are screwed and doweled to the base of the supports. During the rotation of the wheels, the friction produced by the rubbing of the wheels against the shoes prevents the fixture from being damaged should the operator lose control while indexing; at the same time it relieves the shaft at each end of a certain amount of the weight.

After the joint of each half of the housing has been milled, the parts are ready to be placed in the fixture, which should be in the position shown. The clamp across the center of the

loaded and indexed for drilling, it is run along a track that passes under a No. 14 "Natco" multiple-spindle drilling machine and the eight holes in the flange are drilled at one operation.

Quick-clamping Device

A quick-clamping device is designed for clamping and squaring up the work at *K*. This clamp, illustrated in Fig. 2, is operated by a screw *L* and a hinged clip *M*, the screw being notched at *N* to receive the clip. To release the clamp, the clip is swung back until it assumes the position shown in the lower view. The clamp may then be brought back until it touches the face of the lug at *P*. This method is reversed when squaring up and clamping the work, except that a quarter turn is given to the screw after the clip is in place so as to exert the necessary clamping pressure on the work.

¹Address: New Britain Machine Co., New Britain, Conn.

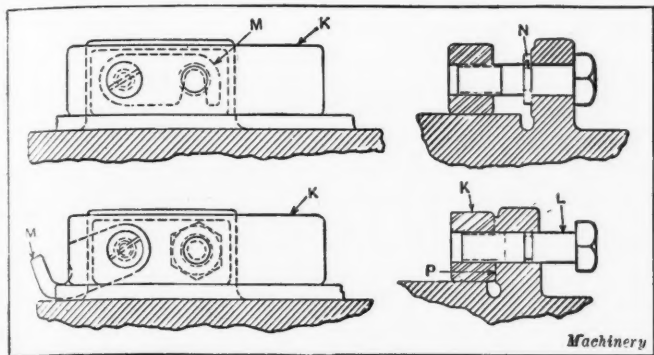


Fig. 2. Device for quickly clamping and squaring up Work

Ninth Operation on Housing

The ninth operation on the rear axle housing is turning out and sizing the recess on both sides of the housing to receive the rear axle tube, after both halves of the housing have been bolted together. This operation is performed on a No. 7A Potter & Johnston turret lathe. Fig. 3 shows the tools required and the method of setting up.

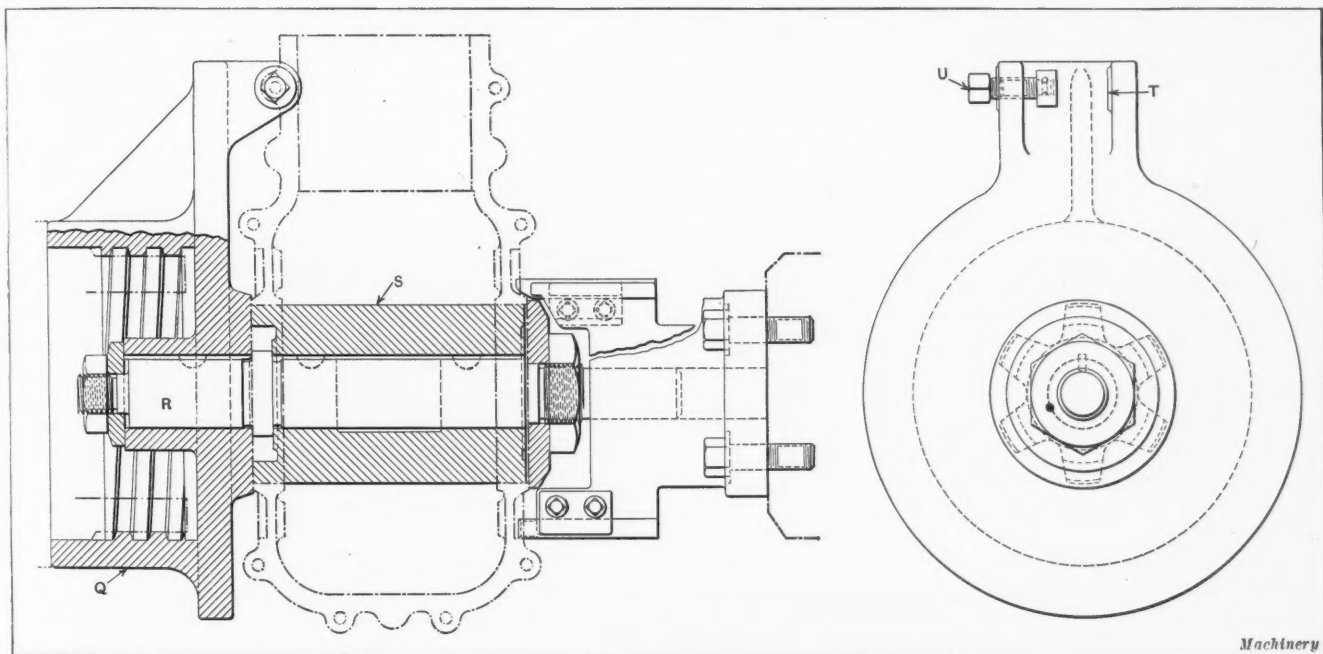


Fig. 3. Fixture for recessing Both Sides of Housing

This fixture consists of a faceplate Q screwed onto the spindle of the turret lathe. This faceplate serves as a base for the rest of the holding mechanism and also to drive the work. A shaft R is pressed and keyed into the faceplate and held in position by a nut and washer. A spider S, keyed to the shaft, serves to locate the work, a U-washer and nut holding the work in position after it has been slipped over the spider. The work is driven by clamping the flange against surface T by means of clamp screw U.

After the work has been clamped in position, the turret head is brought forward to perform the recessing. The tools are

held in a tool-holder or head bolted to the turret head; there are three tool-holders with the tool set-ups necessary to complete the recessing properly. The construction of the tool-holder and the method of holding the tools are shown in Fig. 4. On the first operation, three tools are used; V, W and X in Fig. 5 show the relative position of these tools as they perform their work.

The tool-holder for the second recessing operation contains two tools, which finish the radius and carry the recess to the proper depth. These two tools are alike and are wide enough so that they may be alternately nicked in order to break up the chips. In the third operation, the tool brings the outside diameter of the recess to the finished size. After one side of the housing has been completely recessed, the work is slipped off the arbor, turned, and then replaced so that the opposite side is in position for recessing.

* * *

The *Gazette de Lausanne* for November 18, 1917, published a telegram from Berne, Switzerland, according to which a member of the Krupp Co., of Essen, Germany, has attempted to form an organization which, if it succeeds, would have a

sinister influence upon Swiss journalism. Briefly, the organization is to sign advertising contracts on behalf of the German industries with a considerable number of Swiss trade and general journals. It is also stated that the object of the proposed organization is to purchase the business of Swiss firms that have suffered through the war. Their business would thereafter be continued by Germans, but under the former Swiss names. Through these Swiss firms, Germany would purchase, after the war, raw materials and goods which could not be obtained directly, and would sell under a Swiss label the products of German industry.

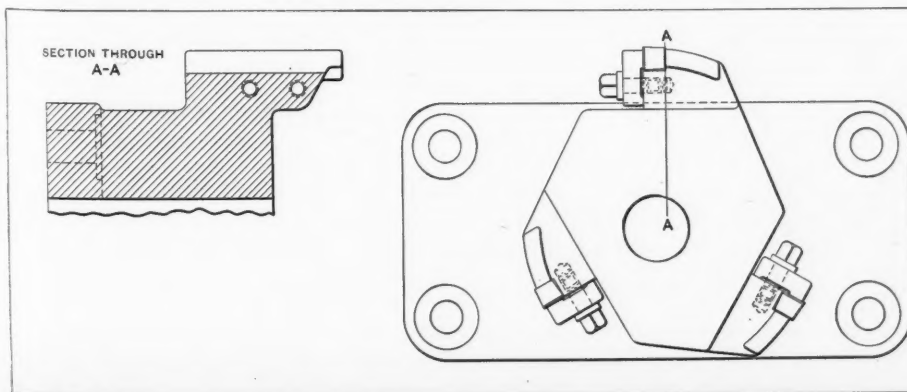


Fig. 4. Tool-holder used when recessing Housing

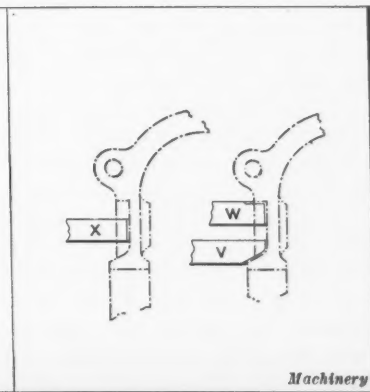


Fig. 5. Tools for recessing Housing

DEFECTIVE FIRE ESCAPES

BY CHESLA C. SHERLOCK¹

Employers are more or less familiar with the law requiring the maintenance of proper fire escapes, and they know their liability to the state or municipality in case they fail to comply with the various statutes and ordinances. Recently, however, the question has been raised as to whether an employer is liable to an individual in an action for damages for a failure to provide proper fire escapes, as contemplated by the statutes and ordinances. Employers have been compelled to take certain measures to protect the individuals in the community from the fire hazard while on the premises used or occupied by the employer; though this regulation does not limit itself to employers, it applies to all owners of buildings, and in some instances to tenants. The term employer is here used in a loose sense, as it is the purpose to limit the discussion to cases between employer and employe.

The theory upon which the state has compelled obedience to its safety acts has been that it is a valid exercise of the police power of a state to make such requirement of employers. It can be seen, then, that to bring up a situation where an employe or other third person is attempting to profit individually from the employer's failure to comply with a statute that involves a question concerning the community at large is unique, to say the least. It is not common to permit an individual to bring an action in damages for a breach of duty owed to the community at large and not to the individual in particular. In a recent case involving this point, the Supreme Court of Nebraska was of the opinion that the violation of any statutory or valid municipal regulation established for the purpose of protecting persons or property from injury is sufficient to prove such a breach of duty as will sustain a private action for negligence, if the other elements of actionable negligence concur. The mere fact that the statute or ordinance in question does not, in terms, impose a civil liability for its violation does not affect such evidence of its violation as may go to show negligence.

The general liability of an occupant of a building has had more attention from the courts than the point just mentioned. Many courts hold to the opinion that a tenant has a right to assume that the landlord will comply with the provisions of the statute relating to fire escapes and that the tenant is under no legal obligation to perform that duty in the failure of the landlord to act. One court has said that a tenant is under no obligation to act even though he discovers that the landlord has violated the provisions of the statute, for he has a right to assume that the landlord will not continue in his breach of the statutory duty. The mere length of time of occupancy, in the opinion of the New Jersey court, unaccompanied by some affirmative act or circumstance on the tenant's part showing an intent to relieve the landlord from the consequences that might result to the tenant from the landlord's failure to perform the statutory duty imposed upon him of erecting fire escapes, cannot relieve the landlord from responding in damages in case a fire breaks out and the tenant suffers injury by reason of the absence of fire escapes.

In a Minnesota case, where a statute required one non-combustible ladder or stairway for each twenty persons, or fraction thereof, that the building accommodated above the first story, but did not state how far down the ladder should extend, it was held to be a question for the jury whether there was negligence on the part of the landlord in not bringing the ladder down closer to the ground than twenty feet, so as to afford a reasonably safe escape from the building. In a Kentucky case, it was held that the mere fact that the building in question was erected before the enactment of the ordinance does not relieve the landlord from liability for failure to comply with its provisions, since it applies to buildings erected before as well as after its enactment.

The New York courts have plainly said that an employer who fails to equip his building with fire escapes as required by statute is liable for the death of an employe due to such failure, regardless of the question of his negligence in other respects. The Illinois courts have said that where the occu-

pant of a building fails to comply with the law requiring metal fire escapes that he is liable in an action for negligence to anyone lawfully in the building at the time the fire breaks out and injured because of the inadequate means of escape.

The Indiana court has gone a step farther and said that the failure of the owner of a building used for factory purposes to comply with a mandatory statute requiring the erection of fire escapes was the proximate cause of the injury of a person who jumped from the third-story window in an effort to escape from the burning building. In Pennsylvania, the court said that the owner of a building failing in his statutory duty to provide an adequate means of escape in case of fire cannot claim that injuries sustained by one in escaping from the building were due to want of familiarity with the means of escape that had been provided. It is not the lack of familiarity with the means of escape, but the inadequacy of the means, that is the proximate cause of the injury in such case.

In another Illinois case, it was held that the mere construction of a fire escape pursuant to a statute does not relieve the owner of the building from further responsibility to his employes, or establish the fact that the fire escape is a reasonable and sufficient means of escape, as the statute prescribes no method of construction. The mere fact that the owner of a building has had no notice from a state or municipal officer to construct fire escapes is not a sufficient excuse to relieve him from the penalties provided by law for a failure to perform this duty.

* * *

STANDARDIZATION NECESSARY IN WAR TIME

A great many airplane engines have been developed both in the United States and Great Britain during the past year—more so probably in Great Britain than in the United States. It has been proposed in England, therefore, that a halt should be called by the government to the multiplication of designs of air engines, and that all plants having facilities for work along these lines should concentrate on the production of a limited number of standard types. Progress might be maintained by encouraging promising experimental work in one or two factories especially intended for the purpose. Nobody but a practical engineer realizes the enormous amount of time, money and skilled labor that may be uselessly expended at the present time in making jigs, gages and special tools for the production of engines or other new developments that may have no justification for their existence. The engines of captive airplanes of German design show that they have traveled far along the road of standardization, and the present policy of the American War Department indicates that the value of standardization is fully realized here, the Liberty motor and the commercial motor trucks being the two most notable examples. The present is no time for hit-and-miss experimenting, but for productive work along certain conservative lines. Speed of production is the main object, and although there may be opportunity for improvements here and there, it is better to accept a good reliable engine that meets the main requirements than to waste time on attempts to perfect details that will only delay victory and peace.

* * *

Nothing shows the rise and decline of the popularity of the bicycle more than the census of 1914, which has just been published. The industry reached its zenith in 1899, when there were 312 establishments, which had 19,760 employes, who received \$29,783,600 in wages and produced goods worth \$31,915,900. In 1889, there were but 27 establishments, and the total value of their output was \$2,568,300. During the five-year period ending with 1904, the industry declined very rapidly; but the increasing popularity of the motorcycle has since caused the industry to grow. Although the number of establishments has steadily decreased, there was over 100 per cent increase in the number of employes in the ten years ending 1914; wages were increased over 300 per cent, and the value of the output nearly 450 per cent. Still, the bicycle has not entirely disappeared from the markets, for, in 1914, 398,899 were manufactured and only 62,793 motorcycles.

¹Address: Box 253, Des Moines, Iowa

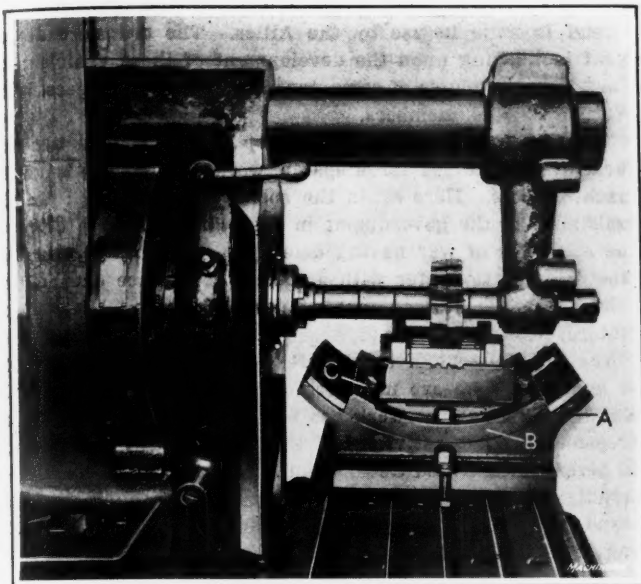


Fig. 1. Milling Steps D and E of Belt Shifter shown in Fig. 5

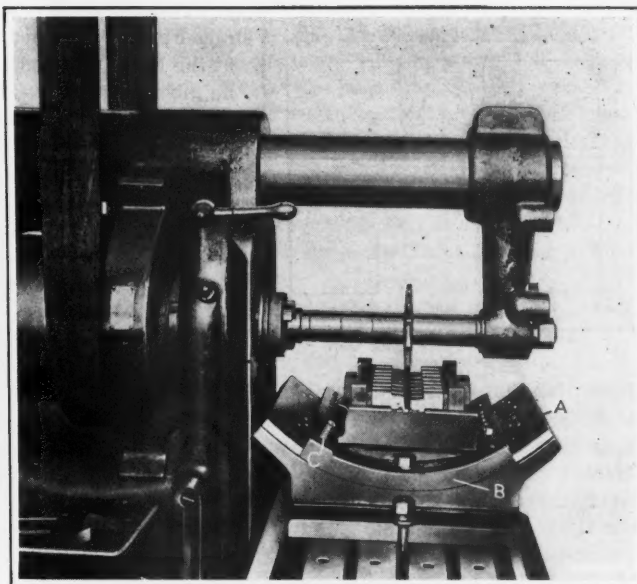


Fig. 2. Milling Central Slot in Belt Shifter

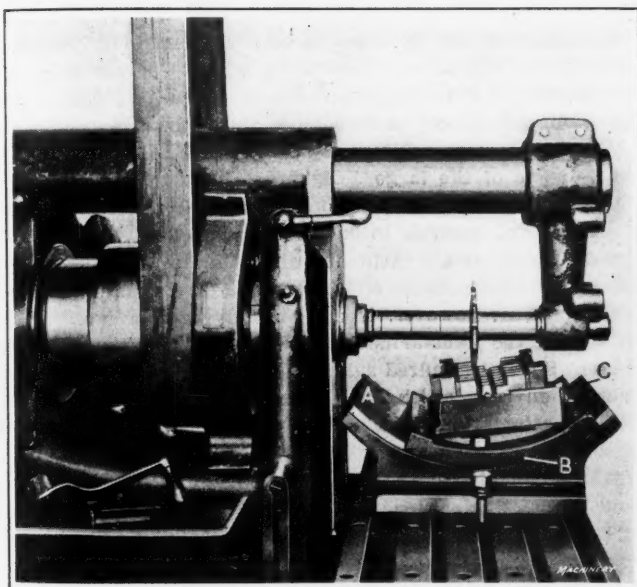


Fig. 3. Position of Fixture for cutting Angular Side of End Slot

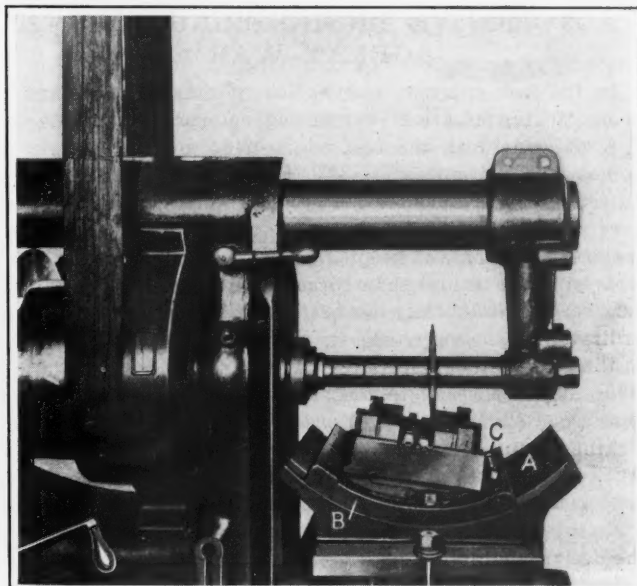


Fig. 4. Fixture moved so that Other End Slot may be cut

EXPORT LICENSES FOR SWITZERLAND

The War Trade Board announces that a trade agreement has been drawn up between the War Trade Board and the Swiss government, covering the issuance of licenses for shipments to Switzerland, and announces the following rules:

Applicants must first procure an S. S. S. permit and show the number of same on their application.

Applications should be sent by the applicants to the Legation of Switzerland, 2013 Hillyer Place, Washington, D. C., who will check up the S. S. S. permit number with their records; and upon their endorsing the application, it will be forwarded by the Legation of Switzerland to the War Trade Board.

Licenses, when granted by the War Trade Board, will be sent to the Legation of Switzerland, who will, in turn, notify the applicant and deliver the license.

Should applicants be refused by the War Trade Board, the Swiss Legation and the applicant will both be notified.

Licenses will not be given until information is lodged with the Swiss consul in New York or with the Swiss Legation in Washington as to the steamer on which the commodities are to go.

SIMPLE BUT EFFICIENT MILLING FIXTURE

BY J. P. BROPHY¹

Occasionally in every line of manufacture we have a piece that is simple to look upon but difficult to machine. Figs. 5 and 6 show a part of a belt shifter used on an automatic machine, the makers of which use eight different shaped pieces of this kind. The stock is flat and one-half inch thick. If the sides of the slots were perpendicular, the manufacture of these pieces would be a simple job, but the sides are not perpendicular, and the angles they form with the bottom differ with each

different shaped piece. As a result, these pieces are difficult to manufacture without the proper form of fixture.

The fixture shown in Figs. 1 to 4 consists of two parts A and B, which are clamped together, when in the proper position, by bolts passing through holes in the lower casting A and slots in the upper casting B. A tongue planed in the bottom of the base A fits a slot in the milling machine table, to which

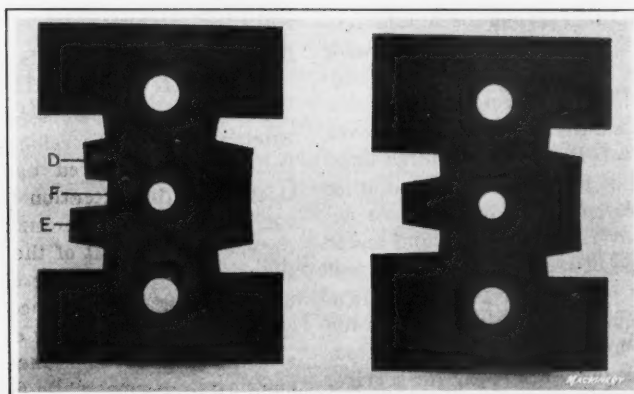


Fig. 5. Belt Shifter Parts on which Fixture is used

¹Vice-president and General Manager, Cleveland Automatic Machine Co., Cleveland, Ohio

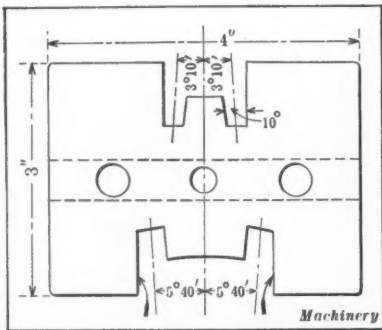


Fig. 6. Angles at which Slots were cut in Belt Shifter

either direction from the center, so by placing the locating pin *C* in the proper hole, as shown by the number, the fixture can be quickly set for machining any shape. Fig. 1 shows the different size cutters milling projections *D* and *E*, Fig. 5; in Fig. 2, the central slot *F*, Fig. 5, is being cut; Figs. 3 and 4 show how the angular slots may be finished. This style of fixture can be used for all kinds of angles, as holes can be placed where desired from zero to its full capacity.

* * *

AUTOMOTIVE ENGINEERING AND THE GREAT WAR¹

In the last analysis, war as fought today is substantially the matching of great engineering enterprises. In the long run, the side with the best engineering genius will win the contest. The organization of the motor transport service required by modern armies is a problem worthy of the best engineering talent, for the unusually severe service conditions make the problems of keeping a fleet of army trucks in operation far more serious than those encountered in normal peace service. Great difficulty has been caused through lack of standardization of motor trucks in use by the Allies. It was left to the American engineers to solve the problem of standardization; and as a result of the years of preparation and experience along standardization lines by the Society of Automotive Engineers, the government now has in process of production a truck that is not only rugged and finished, but can be rapidly produced and is simple and easy to repair. In every possible case, the standards created by the society have been used in the design of this United States war truck.

The work of the society has not, however, ended with the completion of the design. The organization within the quartermaster corps that will handle such matters as the production, inspection, and the operation of military trucks is largely made up of automotive engineers, practically all of whom are members of the S. A. E. who have entered the service. In addition, the engineer corps will use a large number of trucks for handling the materials; in all probability these trucks will be identical, as far as the chassis is concerned, with those now being provided through the quartermaster corps. Other branches requiring special motor-propelled equipment are the ordnance department, the signal corps, and the medical corps. Light, high-speed trucks to act as airplane tenders will be used by the signal corps, and the medical corps will use somewhat similar chassis for ambulances.

In the ordnance department another group of automotive engineers, S. A. E. members for the most part familiar with design of tractors, is working on the problem of motorizing the equipment. Heavy ordnance, which heretofore it would have been difficult to move successfully, is now drawn over ground almost impassable otherwise. In addition, a large number of four-wheel drive trucks will be provided for the handling of ammunition; these vehicles are comparatively modern developments suitable for operation over rough ground and under conditions where the ordinary type of road vehicle would find it difficult to secure the necessary foothold. So far as known, the government has made no announcement as to its plans for the development of tanks. It is by no means to be doubted, however, when the troops of this country are ready for service,

the base is bolted. The upper part *B* is turned to fit the lower part so that no gib is required. The parts to be milled are held in place by a set-screw, which is not shown. Each shape has its own number, and these numbers are stamped upon the top surface of the base *A*. The upper part of the fixture can move in

that they will be provided with equipment of this character second to none in use by the Allies. The ordnance department is working upon the development of these vehicles; the work is in the hands of competent automotive engineers, many of them S. A. E. members.

The motorcycle used for war purposes is made in two- and three-wheel vehicles for dispatch work and for transporting machine guns. Here again the society has rendered effective assistance to the government in the standardization of parts, the secretary of war having delegated officers in the quartermaster corps to confer with a society committee on problems relating to the development, standardization, and use of the motorcycle.

The development of the Liberty engine is properly credited to engineers who are members of the Society of Automotive Engineers and whose work has been greatly facilitated by the present and past activities of the society. Due credit must be given to the Allied Governments for data, but this engine is strictly an American product designed for rapid production, standardization, and interchangeability of parts. The aviation engine is a high-strung piece of apparatus, one that must develop a great power with minimum weight. The engine operates under full load and at high temperature practically all the time, so that its depreciation is relatively rapid. This greatly increases the service problem and new parts must be supplied frequently in order to keep the maximum number of machines in operation. The society is justly proud of the work its members have done in connection with the production, inspection, and upkeep of aeronautic apparatus.

The submarine problem may possibly be solved by the adoption of one of the large designs of seaplanes now being perfected. The flying boat no longer is a matter for speculation. It has proved possible to build a machine with the seaworthy qualities of a small yacht and at the same time able to take the air, for the purpose of locating and destroying submarines. The seaplane, however, is not the only type of craft used in attacking the submarine developed by the automotive engineers. Several hundred submarine chasers have been used for months on the British coast with the result that submarines seldom attempt navigation less than one hundred miles off shore. The design and construction of engines used in many of these submarine chasers constitute another of the problems that automotive engineers have handled with marked success.

The development of small stationary or semi-portable units for the operation of the wireless set, the searchlight, pumps, isolated electric lighting plants, and machine tools in portable repair shops is another of the details handled by automotive engineers. While many of the types of automotive apparatus are as useful in industrial activities as in what may be termed direct military operations, for instance, the trucks used for handling materials in our great munition plants, the development and production of the farm tractor is equal in importance to any direct military activities. The farm tractor is playing a tremendous part in the production of food, which will, after all, be the determining factor in winning the war. In any branch of the service, whether here or with our men in France, where automotive apparatus is made or used, there will be found the automotive engineer striving to do his part, always willing to cooperate with his fellow-men, and always looking for more work to do.

* * *

MECHANICAL ENGINEERING IN THE BUILDING OF THE PANAMA CANAL

In his address before the American Society of Mechanical Engineers at the occasion when honorary membership in the society was conferred upon him, Major-General George W. Goethals called attention to the work performed by mechanical engineers in the construction of the machinery required for the carrying out of the great civil engineering work represented by the canal. He also mentioned that the satisfactory working of the canal since its completion is in a great measure due to the machinery of the locks, the dredging equipment, and various other appliances which are the work of mechanical engineers. Hence, while the canal is looked upon mainly as a civil engineering feat, it nevertheless is also a tribute to the skill of the mechanical engineer.

¹Abstract of a paper read before the Engineering Society, of Buffalo, in October, by George W. Dunham, president of the Society of Automotive Engineers and member of the Board for Motorizing Field Artillery of the U. S. A.

POSSIBILITIES OF DOUBLE HEAT-TREATMENT OF STEEL¹

The time has arrived in America when we are obliged to lay more emphasis than ever on the question of quality and higher standards for steel for special work. We have nearly reached our limit of quality in cheap steel, as far as chemical and mechanical manufacture is concerned, but in the field of heat-treatment there is a great deal that can be done and without much expense. Most steel workers have had tools burst when quenching and are familiar with the hollow that frequently forms down the entire center of a tool due to the stresses in cooling. Casehardened articles are particularly liable to these stresses. It is the same way with armor plate, which is case-hardened to perhaps as high as 2.5 per cent carbon on the surface but is down as low as 0.25 per cent in the back; this naturally causes all sorts of stresses, particularly in curved plates. One famous English metallurgist heats his armor plate to about 1000 degrees C., cools it very slowly to about 700 degrees, and quenches it; then in order to get it fibrous he reheats it to about 650 degrees C. and quenches it.

That heat-treatment changes the molecular structure of steel is shown by the fact that any steel heated to about 775 degrees C. will lose its magnetism, and magnetism is usually admitted to be a molecular change. Yet the magnet steel invented by Sir Robert Hadfield, which contains about 2.75 per cent silicon and has as little of any other ingredient than iron as possible, when subjected to a double heat-treatment is changed to the most magnetic substance we know; it is even more magnetic than chemically pure iron. One of the most important results of heat-treatment is to change the size of grain for the reason that, every other condition of the steel being the same, if the grain size is small, the steel will be strong and tough, while if the grain size of the same steel is large, the steel will be weak. The object of almost all double heat-treatments is to produce a small size of grain in steel, for the highest strength and ductility is invariably accompanied by the smallest grain size.

The large size of the ferrite grains produced in one of the heat zones has given rise to many double heat-treatments, but it has not been understood as a rule. The only way to do the thing is to heat to between 700 and 900 degrees C., depending on the carbon content of the steel, and quench as rapidly as possible; then heat to just below 700 degrees C. and quench again. This is a common double heat-treatment for all steels of medium carbon that are to be of high quality, because in these medium-carbon steels the ferrite forms a large portion of the mass, and if that can be obtained in small grains, a good quality of steel is cheaply obtained from a steel that would otherwise be much inferior. Steel containing approximately 0.30 to 0.35 per cent carbon and 0.10 to 0.15 per cent vanadium without chromium or nickel is commonly heated to 900 degrees C., quenched, heated to, say, 600 degrees and quenched. If it is desired to have the steel a little stronger and not quite so ductile, the second heat should come to 500, 400, or even 350 degrees, depending on the amount of strength desired. Vanadium also has the effect of making the absorption of the ferrite in steel take place very slowly; consequently it is necessary not only to heat slowly to 900 degrees, but to hold the metal there for some minutes in order that all the ferrite will be absorbed. Some advise heating above 950 degrees, cooling to 875 degrees, and quenching. Exactly the same result is obtained by heating a little more slowly to exactly 900 degrees, or else heating to 950 degrees and maintaining that heat a while.

Axles are heated to about 720 or 730 degrees, quenched, heated just below 700 degrees, and quenched again. Axles containing chromium and vanadium are heated a good deal higher, quenched in oil, and heated above 700 degrees, which heat is maintained for about twenty minutes and then allowed to cool slowly. The chromium has so strong a tendency to retain the carbon dissolved in the steel that if the steel is quenched it will be too brittle.

Casehardened gears are cooled to atmospheric temperature, then heated to between 700 and 900 degrees C., depending on the carbon content, quenched, heated above 700 degrees, and quenched. As the core of the gear contains only a small amount of carbon, so that it is rich in ferrite, the first quenching toughens the core by bringing it rapidly through the ferrite range, thus preventing the ferrite grains from increasing in size. The first quenching gives a tough core and a brittle case, and the second quenching gives the fine grain case. As this is quite brittle, it is usually annealed by heating to about 200 degrees C.

One reason the double heat-treatment has been neglected is that when steel is heated up to the austenite range, an enormous size of grain is produced. Steel heated up to this point has been known as burnt and as overheated steel, but it is possible to remove any bad effects of that treatment. The steel is heated to this high temperature and quenched, and then all the bad crystallization is removed by heating, say, to 1100 degrees C., quenching, heating to 800 degrees and quenching, and finally heating to 700 degrees and quenching. If ordinary commercial, Bessemer, low-carbon steel is heated to 1400 degrees C., quenched in water, heated to 750 degrees, and quenched in water, its strength will be increased from two to four times without decreasing the ductility more than 25 per cent. If a little more elaborate process is used, a steel over 200,000 pounds per square inch tensile strength with a good degree of ductility will be obtained at only a slightly greater cost than ordinary Bessemer bars or rods.

Vanadium keeps the cementite from segregating into coarse grains, and to some extent keeps the austenite from coarsening in this range. It is for that reason that vanadium has been used in high-speed steel, for these steels may then be heated to a very high temperature without acquiring such a coarse grain. The result has been an increase of 60 to 100 per cent in the service of the steel. Nickel has a similar effect, and 12.5 per cent nickel steel will stand considerable overheating in the austenite range, without coming to as much harm as straight carbon steel. When the steel contains 25 per cent nickel, it can be heated to almost any point without getting coarse crystallization. Vanadium exerts its influence chiefly on the cementite, and nickel chiefly on the ferrite. Most of the nickel dissolves in the ferrite in steel, whereas most of the vanadium dissolves in the cementite, so that a small amount of nickel is exceedingly advantageous in steels to be heat-treated in the ferrite range where the ferrite is to be kept small. Manganese has the same effect as vanadium and nickel in keeping the grains of austenite small. Nickel-vanadium steel, manganese-vanadium steel, chromium-vanadium steel give many combinations that afford an almost endless line of possibilities.

By cooling steel to liquid-air temperatures, Sir Robert Hadfield has made bars of manganese steel and 25 per cent nickel steel that are strongly magnetic on one end and as non-magnetic as lead on the other. All these steels are normally non-magnetic, but by cooling to the temperature of liquid air that end becomes magnetic. This opens a line of possibilities with heat-treatment that as yet have scarcely been touched.

* * *

STRENGTH OF PIPE JOINTS AS AFFECTED BY TYPE OF THREAD

The Research Department of the National Tube Co. has conducted an investigation with a view to developing a pipe joint having greater resistance to impact and vibration than the present joints. The different joints tested were regular Briggs pipe thread joints, and a joint in which the pipe had a thread with a round bottom and top and the coupling had a regular Briggs pipe thread. According to the *American Drop Forger*, these tests made it possible to draw the following conclusions: (1) The round thread is superior to the Briggs thread in tensile strength of joint, in impact resistance, in the amount that threaded pipe may be bent, and in resistance of the joint to vibration. (2) Annealed joints are more resistant to shock, bending and vibration than unannealed, and equally strong in tensile strength. (3) Steel joints are superior in every way to those made from wrought iron.

¹Abstract of an address delivered, in October, 1917, before the Steel Treating Research Society of Detroit, by Prof. Bradley Stoughton, secretary of American Institute of Mining Engineers

THE THIRD LIBERTY LOAN

HE ALSO FIGHTS WHO HELPS THE FIGHTER FIGHT—BUY LIBERTY BONDS

THE third Liberty loan will without doubt exceed in amount the combined total of the two preceding Liberty loans. The probable date of offering will be March 1, but the details have not yet been decided upon, and are subject to such change as the rapidly changing conditions of the war may warrant. No loan of such proportions can be successfully absorbed unless the entire nation responds and every citizen prides himself on the practice of self-denial, so that he may subscribe to the limit of his ability. All Americans must be prepared to spend less on themselves, if they are to do their full share for their government in this hour of need. Luxuries and extravagance must go completely out of fashion; necessities only should be purchased, and no one should hire others to do for him the things which he can do himself.

Complete Readjustment Inevitable

As a belligerent, this country has outgrown the idea of "business as usual." There is not enough labor, transportation, coal or other raw materials to go around if those industries which are not essential to the conduct of the war are continued at normal productiveness. The expansion of the essential war industries is only possible if other industries are gradually absorbed, the same as they have been in England and France. Every unessential industry which continues in operation bids against the nation.

Everyone must feel that he personally places himself behind his government—that the country depends on him. Each must do his share. The war requires putting men in the field and keeping them fed and clothed. It requires the production of ships, shells, guns and rifles, motor trucks, saddlery, airplanes, hospital supplies, food, and a great variety of goods, the production of which calls for vast industrial plants from one end of the country to the other, manned by millions of men and women who serve their country as effectively as our soldiers and sailors.

If the American people continue to require all the pleasant and comfortable luxuries which they consumed before the war, they are making it necessary for thousands of factories and shops, employing millions of men and women, to produce articles that do not help to bring peace a day nearer, when they might be devoting themselves to the production of the necessary things which will help to make the Allies victorious. Both things cannot go on together. We have pledged the honor of our country and our people to fight this war to our last dollar and to our last man, if necessary. America does not break her word. The necessities of the war must be produced and must be produced quickly. The key to the situation, therefore, rests in the hand of the average man and woman, who can, by refraining from everything not absolutely necessary to health and efficiency, release strong arms to the production of materials of war and the support of our army and navy. This is the philosophy of labor and materials. This is the lesson which must be immediately brought home to the people of America.

Fallacies which Need Correction

There is a widespread assumption that money is a miraculous worker and can, in some mysterious way, produce. Money produces nothing—it is labor and materials which are required, and money is only needed by the government to buy labor and materials; hence it is the production of the things that are needed in the conduct of the war that must be increased, and the production and use of the things with which we can do without for a time that should be discontinued. Labor and materials are the only things that count in the conduct of the war, and they cannot be bought if they do not exist. Every non-essential industry which burns coal deprives an essential industry of the supply available for a necessary purpose. Every dollar spent on luxury bids against the United States when the nation buys war materials.

It has been believed that some virtue attaches to the keeping of money in circulation by freely expending it. This is a fallacy. Money is kept in circulation in a useless and injurious way at the present time if spent for non-essentials or luxuries; but it is kept in useful circulation if invested in Liberty bonds to be employed for a successful prosecution of the war. Money spent in the buying of Liberty bonds gets as wide and immediate a circulation as if spent on theater tickets and it goes to support the industries which produce those things which the government needs.

Importance of Present Savings

The war is fought entirely on present savings, labor, and materials; hence the imperative necessity for thrift, not only on the part of those who have never before put aside anything, but also on the part of those who normally would be spending the income from past savings. In either case, it is the duty in the present situation to practice self-denial in the matter of consumption, in order that more may be turned over to the government in the form of Liberty bond investments. Briefly, it is every citizen's double duty to produce more and consume less. To inspire the average citizen with zeal in this twofold effort, and to justify his mind in this unaccustomed sacrifice for the common good, it is highly necessary that he should realize that with every dollar put into Liberty bonds he stands back of the fighters at the front.

In a month or so, the subscription lists will open for the new big war loan. Begin to prepare for it immediately. This loan will probably be so much greater than either of the two preceding bond issues that, in order to meet the demand, every man and woman must place at the disposal of the government every dollar that they can spare. All must feel that they and the United States are one in this fight against autocracy and for a world made free for democracy.

* * *

GERMAN SHIPS IN AMERICAN HARBORS REPAIRED

All the damage done to the 109 German ships in American harbors by their crews prior to their seizure by the United States Government when war was declared is now repaired, and these ships are all in service, adding more than 500,000 gross tonnage to the transport and cargo fleets in the war service in the United States. There is evidence that a German central authority gave an order for the destruction of the vital machinery of these ships, effective on or about February 1, 1917, or simultaneously with the date set for the unrestricted submarine warfare, the object being to effect such vital damage to the machinery of all German ships in American ports that they should not be able to put to sea for from eighteen months to two years. There is documentary proof that those who carried out these orders believed that the damage was irreparable. This purpose, however, was defeated in a signal fashion, for in less than eight months all the ships were in service. This is all the more remarkable when it is considered that the campaign of destruction was carried on for more than two months, and that the Germans were convinced that they were doing a thorough job.

Instead of obtaining new machinery, which would have greatly delayed the placing of the ships in service, in nearly all cases it was possible to make the required repairs by means of electric and oxy-acetylene welding. The work of placing the vessels in seaworthy condition also involved an extremely thorough examination of every part of the vessels, as many instances of cleverly concealed injuries were found. Indications show that there was a plan to burn the ships under certain conditions, and it is believed that the German crews were seized and interned somewhat in advance of their expectations. Altogether, the problem presented by the German ships in our harbors has been well handled.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

CAM CUTTING ATTACHMENT FOR MILLING MACHINE

When the designer of the cam cutting attachment shown in Fig. 3 was asked what he would call it, he said "just riggin." In the midst of all standardization with special tools that reduce the effort and error of production to a minimum, amid the humdrum life of jigs, fixtures and gages, there exists in the heart of every true mechanic a good deal of love for "just riggin." For him life takes on a new zest when the "Big Boss" comes with a tale of woe of a broken machine or something else that has smashed the everlasting sameness of the usual operation on the regular machine. One of these jobs came up at a machine tool plant when a cam with a 7/16-inch rise, as shown in Fig. 1, had to be cut. The usual method of doing this when the rise of the cam is less than the smallest lead of the machine is shown in Fig. 2. A milling machine with a vertical attachment is used, the end-mill being turned parallel to the axis of the dividing head spindle. The

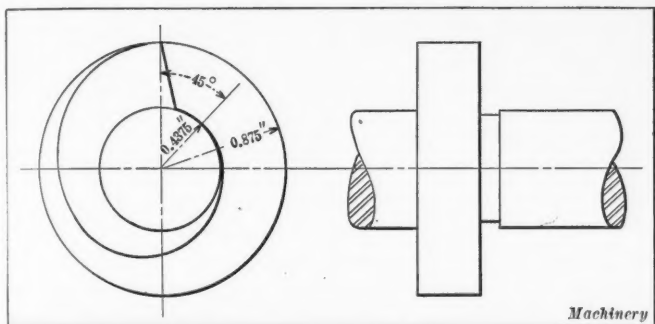


Fig. 1. Cam to be machined

sine of the angle A , at which the dividing head is elevated, is equal to rise of cam divided by lead for which milling machine is geared. This gives a mathematical relation between the forward motion of the table, the revolution of the dividing head spindle and the angle at which it is set, which gives the lead desired.

However, in this case a milling machine with a vertical attachment was not available, and it was necessary to interpose sufficient gearing to reduce the smallest lead from 1.55 inch to 7/16 inch. To do this the dividing head was set at right angles to the travel of the table, the dividing head spindle being parallel to the axis of the milling cutter. A pair of bevel gears was used to connect the revolving motion of the dividing head with the table traverse motion; these were 1 to 1 gears taken from stock. To secure the reduction, the gears at the end of the table were assembled as shown in Fig. 3. The bevel and reducing gears were held in place by means of two

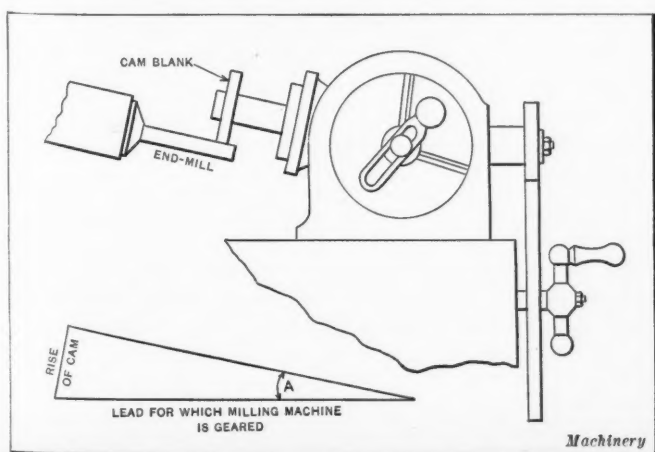


Fig. 2. Usual Method of setting Milling Machine for Operation

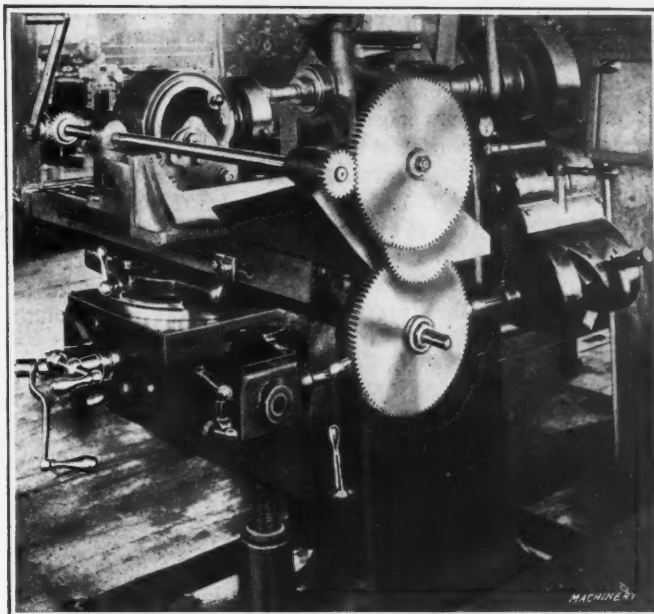


Fig. 3. Special Attachment used for cutting Cam

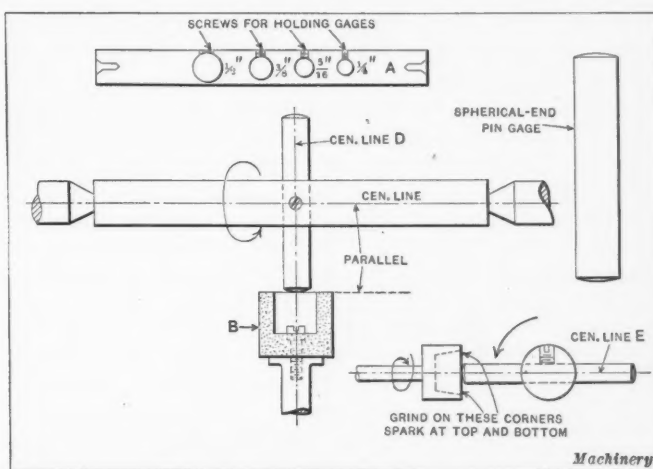
special castings which were bolted to the table of the milling machine. The crank shown attached to the bevel gear at the dividing head was used to revolve the work and move the table. The resulting cam was as accurate and workmanlike in every particular as though the regular method and machine had been used.

Cincinnati, Ohio

D. M. PERRILL

GRINDING SPHERICAL-END PIN GAGES

Pin gages are preferred to plug gages by many mechanics, especially for large holes that must be round and straight. Taper and out-of-round errors can be easily detected with the pin gage. Except for adjusting micrometers, pin gages of the type here illustrated are seldom used for shop work, due, per-



Method of grinding Spherical-end Pin Gages

haps, to the difficulty experienced in grinding the ends perfectly spherical. Most mechanics just file the ends to a sharp point and let it go at that, making a fair gage but rather unsatisfactory for permanent use. Quick and satisfactory results can be obtained by the following method and with but one special tool:

The arbor A is made of tool steel and has several holes drilled and reamed through the center to take the various diameters of stock used for making the different lengths of gages, screws being provided to hold the gages from slipping

The grinding wheel is nothing more than a cup-wheel *B* mounted on a toolpost grinder and used in a lathe. After roughing the gage and hardening the ends, the gage is placed in the proper hole in the arbor *A*, placing the arbor on the centers of the lathe as illustrated and adjusting the wheel as nearly as possible by the eye to agree with center lines *D* and *E* and having the face of the wheel parallel with the arbor. By rotating the gage slowly by hand past the wheel and noting the sparks, it is easy to see if the wheel is too high or too low. When the wheel just sparks on the top and bottom, the wheel is right for center line *E*. Center line *D* must be determined by measuring the pin gage and adjusting the lathe carriage sidewise until the contact points of the micrometer, when swung back and forth parallel with the arbor, strike at all points on the gage. The wheel revolving in the direction indicated by the arrow and the work being swung up and down past the wheel by hand, generates a sphere. The accuracy depends on the alignment of the wheel face to the center of the arbor and the center lines of the wheel to the center of the arbor and the center of the gage.

Care should be taken to see that the wheel cuts only at the inside edge of the wheel and that the screw which holds the wheel in place does not project far enough to strike the work when swung past the wheel. If care is taken in grinding, little or no lapping is required.

Derby, Conn.

GEORGE SLIDER

The principle of this method of grinding spherical-end pin gages is geometrically correct, but it may be somewhat difficult to see without some explanation. The inner edge of the cutting face of the cup-wheel lies in a plane that intersects an imaginary sphere whose center is at the intersection of the axes of the wheel-spindle and the work-arbor, and whose diameter is equal to the length of the pin gage being ground. The cup-wheel characteristic in this case is that it grinds with the inner edge only. The end of the pin gage ground in the manner described lies within the section of the spherical surface intercepted by the plane coinciding with the end of the cup-wheel, and because of the characteristic of the wheel referred to, it must have a spherical end when finished. If the cup-wheel had an internal diameter equal to the length of the pin being ground, it would have to be moved toward the work until its grinding plane would intersect the axis of the arbor in which the pin is mounted, which, of course, is impossible; but when considered as being in this extreme position, the spherical generating action becomes somewhat clearer.—EDITOR

EFFICIENCY POINTS IN BORING FIXTURES

Special emphasis should be placed on the superiority of the inserted tongue over one made integral with the fixture, as described in the December number of *MACHINERY*, page 343. Some may question the statement that the inserted tongue design is the cheaper to make, for the integral tongue looks cheaper to the fellow who never made one and to the shop man who regards the word "cheap" as synonymous with shoddy. The table slots on any reputable make of planer, milling machine or boring machine are practically exact to some standard size. Stock sizes of cold-drawn steel will usually fit the slots closely enough for all practical purposes, and any operator of a planer or milling machine will admit that it is much easier to cut a slot to fit a piece of steel that he can use as a gage than to try to form a tongue on the base of a fixture that will fit a slot on some machine. The principal difficulty is usually the impossibility of using a micrometer

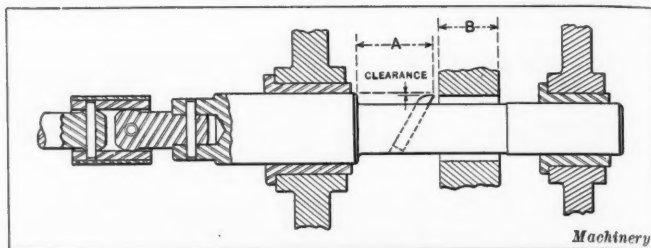


Fig. 2. Boring-bar that may be removed from Fixture without disturbing Setting of Cutters

on the tongue, unless it projects from the base much farther than it should.

The natural tendency of designers is to have the tongue enter too far into the slot; the use of $\frac{1}{2}$ -inch stock, $\frac{1}{4}$ inch in the fixture base and $\frac{1}{4}$ inch in the table slot, is ample for any case, while $\frac{3}{8}$ -inch stock, as shown in Fig. 1, will usually give complete satisfaction. Any machine table that has seen much service will have slots narrower at the bottom than at the top. Edges like *A* and *B* should be beveled. The bevel at *A* will soon be there anyway as the result of filing off burrs raised by inevitable bumps the tongue will receive. If a square corner is left at *B*, it is a very careful man who will keep the corner free from embedded chips, which, of course, will cause stresses in the fixture when it is clamped down. When beveled as shown, the corner is easily kept clean.

There are doubtless advantages to the design of guide bushings that do not fit on the diameter but are held in location by dowel-pins through the flange or head, and it seems that they should be very satisfactory for light boring, such as finish-boring a hole that had been drilled slightly under size so that the cut would be light and of practically uniform depth. For boring cored holes, however, the flange of the bushing should be rather thick, the dowels of large size and hardened, and the screws set up quite tightly to prevent the bushing from working loose within a short time. One good reason is given for using single-point boring tools in certain cases, but these tools are often better for another reason. The first cut with a single-point tool through a hole cored off center may not be quite truly round, but its center will be more nearly in the correct location than if a double-edge cutter had been used. In case of the springing of the bar in boring an eccentrically cored hole, the double-end cutter not only springs from the heavy side, but into the light side, enough perhaps to prevent the finishing cutter from finishing the entire periphery of the hole.

Boring bars should always, if possible, be designed so that they may be removed from the fixture without disturbing the setting of the cutters. Fig. 2 shows a method of accomplishing this without the necessity of having an extra loose bushing on the bearing of the bar. This method, of course, would be hardly practicable except on a part having but one hole to be bored as shown. All that is necessary is to have a clearance between the liner bushing and the point of the cutter; also to have length *A* somewhat greater than *B*, so that the tool may pass well through the work before the bar comes against the part being bored. The hole for the pin at the extreme left-hand end should be slightly tapered or bell-mouthed from each end to permit alignment.

Anderson, Ind.

LEROY M. CURRY

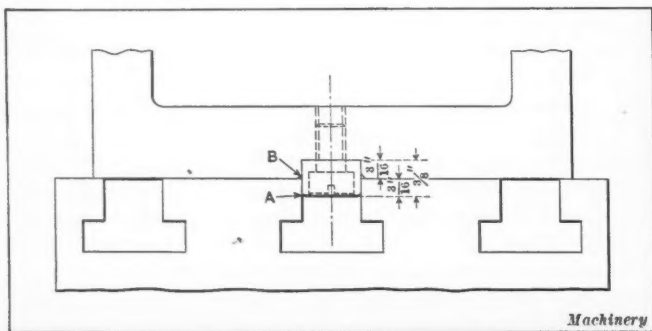
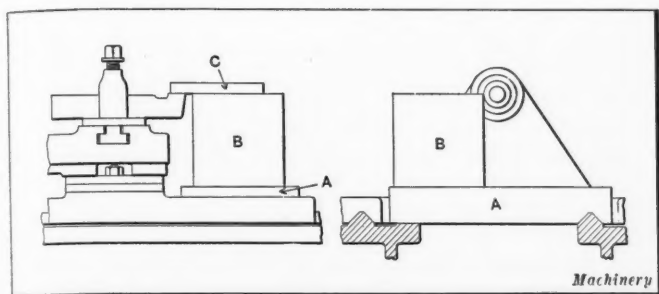


Fig. 1. Satisfactory Method of inserting Tongue in Fixture

METHODS OF SETTING THREADING TOOL

The writer would like to suggest another method of using the threading tool setting gage described in the October number of *MACHINERY*, page 155. Instead of clamping the tool lightly and advancing it gently into the sixty-degree groove of the gage, the tool should be clamped rather firmly at the exact height of the lathe centers and advanced into the groove until one of the cutting edges is within a few thousandths inch of the side of the groove. A white, strongly lighted surface beneath the gage and the tool must be provided in order to set the cutting edge of the tool parallel with the side of the groove quickly and accurately. This is done by noting the shape of the line of light shown between the tool and gage when the



Method of setting Tool correctly

tool is nearly in contact with the gage, and tapping the back end of the tool with a hammer until parallelism has been secured. The tool must be withdrawn from the groove before it is tapped, and each advance into the gage groove must be carefully made to avoid damage to the tool or gage by actual contact between them. When the tool has been correctly set, it is clamped tight. If the tool has been formed accurately to the angle, setting correctly on one side is enough; but as nothing is exact, it is best to try both sides of the tool. It will be seen that in using this method the bottom of the gage groove is not used. This relieves the maker of the gage from forming that part, which is the most difficult. Many tool-makers fail to realize the need for the whole of the cutting edge or edges of a threading tool to be radial to the work. It is not uncommon to see great pains taken to set the point of the tool at the height of the center line of the work while the cutting edge is not radial. A good method of setting the tool is to provide a plate *A* and block *B* as illustrated. The top surface of the plate must be parallel with the cross-slide, and the block height must be such as to bring its top surface exactly in the plane of the centers. The top surface of the plate should be slightly higher than the cross-slide to allow the block to be extended over to the tool point and the test of tool height to be made by extending a scale *C* from the block to all parts of the cutting edge of the tool. The required height of the block may be obtained by careful measurement from a cylinder of known diameter, between the lathe centers, to the top of the plate, and adding half the diameter of the cylinder.

Wilksburg, Pa.

WILLIAM S. ROWELL

USE OF FLY CUTTERS

When visiting various machine shops during the past few years, the writer has noticed an almost total absence of fly cutters. In fact, many of the younger machinists have never seen one in use, so it might be well to state, therefore, that this is a machining tool that was used quite extensively by our fathers to obtain finished surfaces. Perhaps one reason why the tool was so commonly used was that many of the special tools were made in the various shops where they were employed, with the result that the cheapest tool that would perform the work was made. A different procedure, however, is followed today. When the part is to be finish-machined by a form milling cutter, say, it is usually made by a shop specializing in the manufacture of milling cutters. The cutter is made of a cylindrical shape and with the conventional number of cutting edges, or teeth. The writer has no objection to these tools; but when only a few parts are to be machined, a cheaper tool is to be preferred, if equal results can be obtained.

The fly cutter is made of carbon or high-speed steel, as desired, and of a flat section, say $\frac{1}{4}$ to $\frac{3}{8}$ inch in thickness. Its shape is easily obtained and the cutting rake of about 10 to 12 degrees formed on the cutting edge. The tool is then hardened to suit the material being machined. The inner edge or that opposite the cutting surface, is best machined with a notch the width of the holder and about $\frac{3}{8}$ inch deep, and the shank of the holder should be made to suit the spindle of the machine; the cutter is then held in the holder by either a pin or a set-screw.

One objection that has been made to the fly cutter is that it tends to pull the work into it. The writer has used this tool on both milling and drilling machines and, when ordinary care is used, has experienced no such trouble. On the

other hand, almost any shape can be machined with this tool, but the conventional type of cutter cannot be made for intricate and complicated contours of surfaces. Another advantage of the fly cutter is the ease with which the tool may be sharpened by grinding or stoning. It is simply necessary to remove the cutter from the holder and grind on the flat side; no tool grinder is necessary. This advantage is of especial value to the small shop that has no tool grinder, but sends out its cylindrical tools when they must be ground.

The value of fly cutters is shown by the following example: Some time ago the blades of a steam turbine, when received, did not have the correct contour. As there were ten sets of blades and each set was of a different shape, ten milling cutters were needed to make the necessary changes. A firm that made the conventional type of cutter asked \$280 for the set and required from a month to six weeks' time. As the turbine was an experimental one, this price and the time required were considered prohibitive; so ten fly cutters were made and a milling machine holder was changed to receive them. These cutters were made in two days and cost only \$20. The blades were held in a vise on the milling machine table and no trouble was experienced during the machining operation. The surface produced was equal to any obtained with an ordinary milling cutter and the time required was no longer. It seems that there is a greater field of usefulness for the fly cutter than has been realized. It may be advantageously used in solving many machining problems of surfaces on both the milling and the drilling machines.

Providence, R. I.

ROBERT MAWSON

REASON FOR SUPERIORITY OF GUN TAP

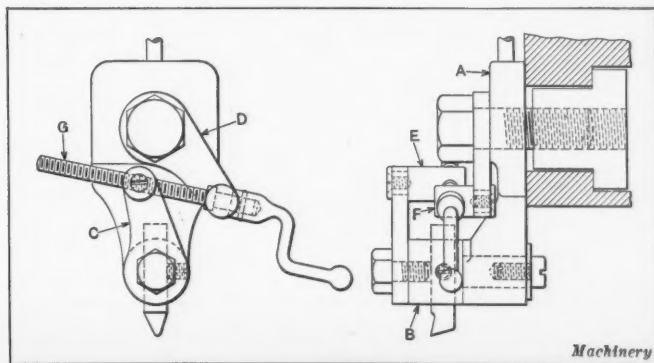
Referring to the article relating to thread cutting in the October number of *MACHINERY*, it may be of interest to note that the reason why the so-called "gun tap" cuts better than an ordinary tap is that, on account of the angle at which the teeth at the end of the tap are chamfered off, the face of the teeth is at right angles to the direction of the helix of the screw thread. Hence the tap will naturally cut better than an ordinary tap with straight flutes. The relation is exactly the same as in a hob for cutting gears. It is well known that the cutting action is better when the flutes are at right angles to the direction of the helix of the hob thread.

Geneva, Switzerland

A. BOLLINCKX

AN ARC-FORMING TOOL

The illustration shows an arc-forming tool for use on a shaper. *A* is a slotting tool-holder, made of tool steel and hardened. Piece *B*, also of tool steel, has a shank that has a bearing in *A*. The portion of *B* containing the tool bit should be an even diameter so that it will be convenient to set the tool bit for any given radius. Arm *C* is made of cold-rolled steel and is fastened to *B* by a cap-screw. Arm *D* is also made of cold-rolled steel and is held on *A* by the bolt that secures the entire tool to the shaper. Piece *E* is tapped to allow screw *G* to pass through it, and piece *F* is drilled and counterbored to form a bearing for this screw. *E* and *F* turn on their axes when *G* is revolved. This fixture can be made to suit almost any radius. If *G* should be too short to cut the entire arc, *C* can be loosened and brought back with *G*, and



Tool for cutting Arcs on Shaper

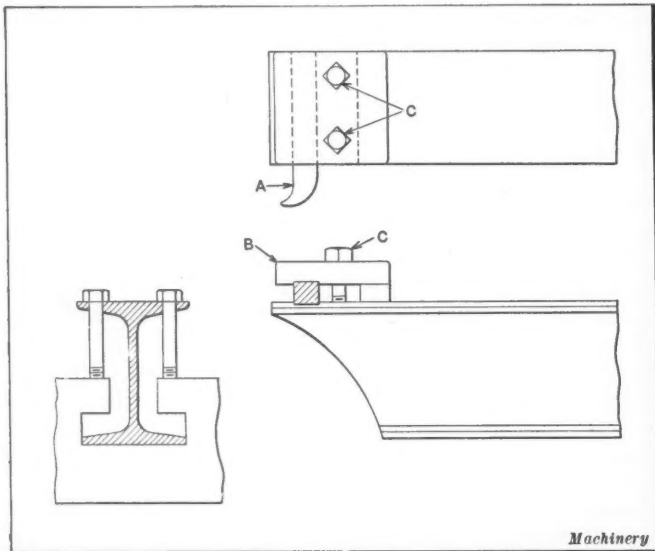
the same cut can then be continued. The screw could be placed in a vertical position if so desired.

Schenectady, N. Y.

P. VUILLE

I-BEAM BORING BAR

The writer had to bore out six-inch diameter counterbores on an engine lathe, and in order to clear a projection on the casting being machined, the boring-bar overhung twelve inches from the cross-slide of the lathe. The illustration shows the boring-bar used, which was a three-inch I-beam, and the methods of fastening the tool and beam. The edges of the lower flange of the beam were trimmed off to allow the beam



I-beam Boring-bar used on Engine Lathe

to slide freely in the toolpost slot. Four holes were drilled in the top flange of the beam, and corresponding holes were drilled and tapped in the cross-slide for the bolts used in clamping down the beam. The cutting tool A was held in position by block B and the beam, which had milled grooves to prevent the tool from pivoting; hence it was not necessary for bolts C to be drawn so tight as when there is no allowance for this feature. This boring-bar was especially stiff, considering the amount of overhang, and worked satisfactorily.

Worcester, Mass.

C. ANDERSON

CIRCULAR CUTTING TOOLS

In the manufacture of circular tools for automatic screw machines, particularly where cut-off tools having a rounded profile are required, the holder and tools illustrated will be of value. In addition to being made at small cost, they can be used for a considerable time by regrinding the faces. The

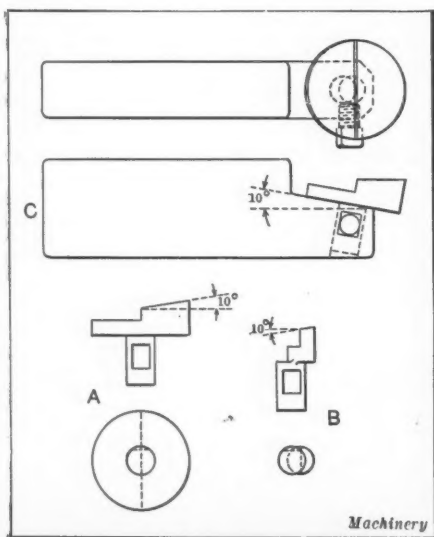


Fig. 1. Arc-forming Tools and Holder

holder can be made of soft steel and pack-hardened, and the tools of ordinary or high-speed steel, the best results being obtained if the tools are ground after hardening. In Fig. 1 are shown tools for cutting arcs of various radii, A being used for radii from 3/16 to 1/2 inch, and B for radii from 3/32 to 3/16 inch. Tool B should have an offset of 1/16 inch when the radius is 3/16 inch, the offset increas-

ing as the radius decreases, to allow the work to clear the tool-holder.

In Fig. 2 is shown a tool and holder for cutting angles. When a tool is required that is wider than the diameter of the hole in the holder, larger stock may be used and a suitable shank turned on it. The tool-holder shown in Fig. 1 could also be used for this tool if a hole were drilled in the end C.

New Haven, Conn.

FREDERICK W. RANDALL

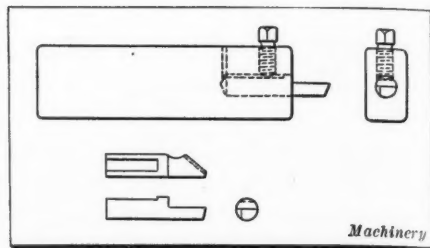
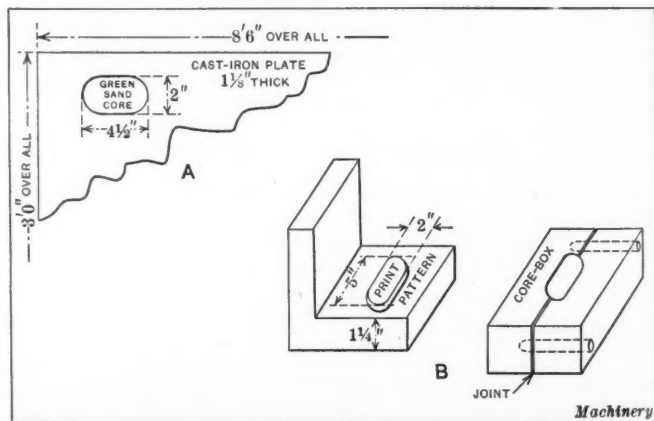


Fig. 2. Angle-forming Tool and Holder

EXAMPLES OF POOR PRACTICE IN PATTERNMAKING

In the making of a great many patterns much labor and time are wasted, and the finished pattern often does not answer the requirements of the foundry. The reason for this is that the patternmaker does not know what these requirements are. Without a knowledge of molding practice it is impossible for a patternmaker to plan his work and predetermine the operations of the molder; he has to resort to guessing. An example of guesswork patternmaking was brought to my attention by the boss molder in a large jobbing foundry. The first casting was a plate, 3 feet wide by 8 feet, 6 inches long and 1 1/8 inch thick; in it were cast eight holes of the shape and dimensions shown at A. These holes were made in the pattern to be molded in green sand. The work of cutting the holes in the pattern was labor and time wasted, and molding them in green sand was contrary to good molding practice.

The practical method is to core these holes. Core-prints and a core-box are quickly made, and the cores can be



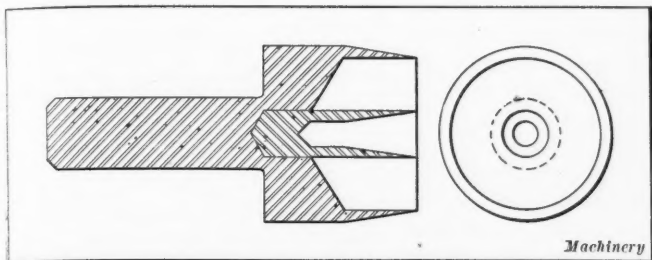
Examples of Poor Practice in Patternmaking

made in a few minutes. To repair one green sand core that has been torn up or lifted with the pattern requires more time and labor than setting the eight dry sand cores in the mold, and with dry sand cores, cleaner holes correct in size are produced in the casting.

Another pattern made by the same patternmaker is shown at B. This small pattern is easily molded and lifted from the mold. The oblong hole is produced with a core, and for this a core-print and core-box were made. The core-box was made in two parts as shown. Now, if cutting the eight holes in the plate to be molded in green sand was considered by the patternmaker to be practical patternmaking, why make the small pattern to be molded with a dry sand core? Again, if the large plate, which is unhandy for the molder to handle, can be lifted without disturbing the green sand cores, then what is the sense of making this small pattern, that is so easily handled, to be molded with a dry sand core? What was the object of making the core-box split through the middle?

Kenosha, Wis.

M. E. DUGGAN



Tool for cutting Rubber Washers

CUTTER FOR SOFT COMPOSITION WASHERS

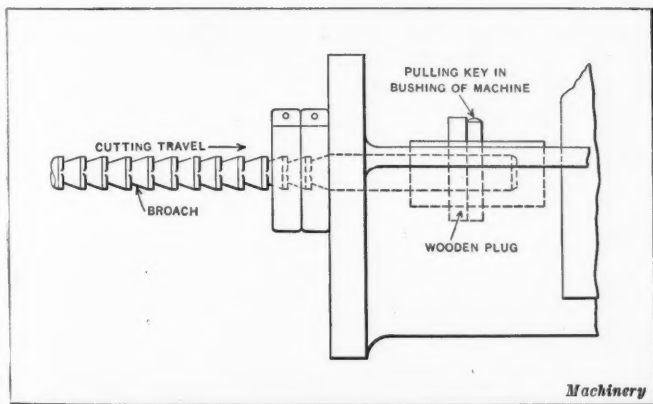
The writer was employed where it was often necessary to make washers from rubber, etc., and a cutter like the one shown in the accompanying illustration was used so that the washers could be cut out on a drill press. The cutters were made from hard brass and drilled. The bevel is on the inside of the cutter that forms the hole in the washer, and this cutter is soldered or held in place by a small brass screw. This tool is quickly made and produces accurate washers. A wooden board should be placed beneath the composition, and the stop on the drill-press spindle set for the proper depth.

New York City

E. J. HIGGINS

SAVING A BROACH

When a straight oval hole was being broached through light drop-forgings, two at a time, the broach frequently broke because too much stock had been left. As a result, the operator had to stay at home until the broach could be welded and the teeth recut. The broach used is 46 inches long and has 107 teeth, which are slightly tapered except the last ten, these being made straight for finishing. The work is done on a Lapointe machine. After the broach is run out to the end of its travel, the forgings are inserted over it and pushed onto



Safe Method of fastening Broach in Machine

the work-holding bushing, being located by engaging with pins. As the slot in the broach is 1 inch by $\frac{1}{4}$ inch, a key that was much stronger than the broach was, at first, used; therefore, the operator substituted for it a wooden plug and a piece of $\frac{3}{8}$ -inch drill rod, which was filed down on two sides to $\frac{1}{4}$ inch. Since then, whenever too much stock is left on the forgings, the drill rod breaks and not the broach, so that it is only necessary to remove one forging from the broach and the other is easily broached. Since making this change, there have been no broken broaches and 20,000 pieces were broached before it became necessary to discard the tool, because its teeth had worn down so much that the hole in the forging was too small.

New Haven, Conn.

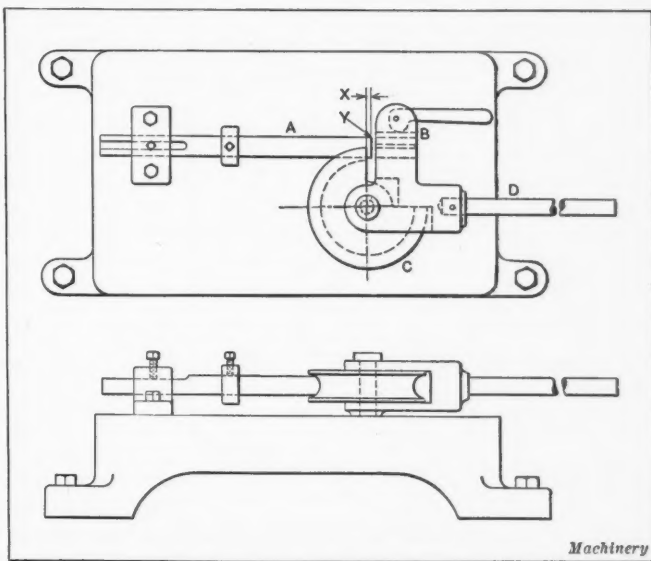
ERIC LEE

TUBE-BENDING DEVICE

The accompanying illustration shows a device for bending brass or steel tubing without wrinkling the inside of the bent portion. As is well known, when bending tubes by the old method of filling the tube with lead, rosin or sand to keep it from collapsing, the bent portion leaves much to be desired

as regards smoothness and appearance, and if plated and polished, the wrinkles become more noticeable. In analyzing the problem, it became apparent that the trick consisted merely in stretching the outside portion of the bend a sufficient amount to keep the inside from crumbling. The illustration shows the fixture that was designed. Arbor *A* is a snug working fit inside of the tube to be bent. The arbor is equipped with an adjustable collar to maintain the proper length from the end of the tube to the bent portion. Clamp *B* holds the tube in place.

The tube is inserted on the arbor and clamped in position. Sheave *C* is then turned by handle *D*, and the tube will be drawn off the arbor and stretched over the sharp edge *Y*. The distance *X* must be determined by experiments and will increase with the hardness of the material being bent. In the



Fixture for bending Brass or Steel Tubing

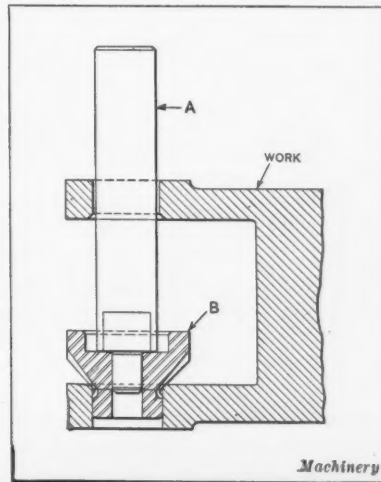
experience of the writer, this dimension was $\frac{5}{32}$ inch for seamless brass tubing, 1 inch inside diameter and No. 20 gage, annealed. For the same size of steel tubing, also annealed, *X* was $\frac{9}{32}$ inch. The device will make a bend of any number of degrees up to a U-bend, and also compound bends. The arbor *A* should be made of hardened tool steel. Lard oil should be used as a lubricant for the arbor.

Oak Park, Ill.

H. W. JESPERSEN

INSIDE COUNTERSINKING

The illustration shows a device that was used on a machine gun part for countersinking two reamed holes from the inside. The driving bar *A* is held in place by a chuck on the drill press spindle; it is slightly smaller in diameter than the holes to be countersunk, and has two flat surfaces at one end. The cutter *B* is placed over the hole to be countersunk and bar *A* is brought down into it, the flat surfaces loosely fitting into an elongated hole in the top of the cutter. When the drill press is started, the revolving of bar *A* causes cutter *B* to revolve, and the hole is countersunk to the desired depth. The shank on the cutter is a good fit in the reamed hole, and this centralizes it during the operation. The work is then reversed and the countersinking operation performed on the other hole.

A. C. BARTMAN, JR.
Hartford, Conn.

Device for countersinking Holes from Inside

DIES FOR STAMP COVER

In Fig. 1 is shown a stamp cover for which the writer designed and built the dies; these are of simple construction and perform the work very satisfactorily. The cover is made in two operations. Fig. 2 shows the combination die for the first operation, in which the blank is drawn and trimmed to the form shown at A, Fig. 3. In this operation, the blanks, which have been cut in a shear, are fed against stop H, Fig. 2. Then, when the ram comes down, the metal is held between A and B while the knock-out pad E draws the 0.07-inch channel on block C. Spring G must be strong enough to hold the metal securely during the remainder of the operation. When

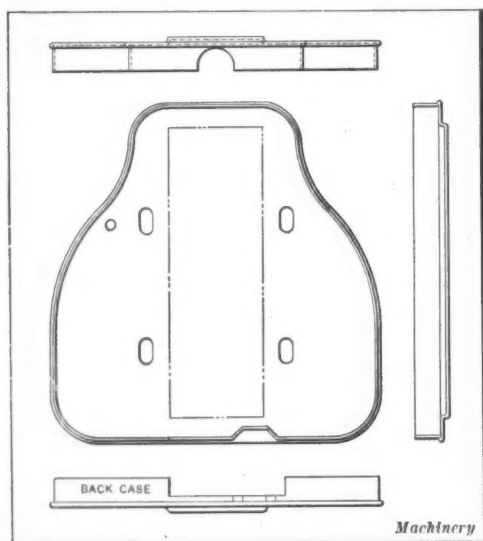


Fig. 1. Stamp Cover made in Dies shown in Figs. 2 and 4

the draw is completed, blocks A trim the blank on block D as indicated by the arrows. The rubber pad F must be stiff enough to hold B tightly against blocks A so as to prevent wrinkling of the stock. Fig. 4 shows the die that performs the second operation, pressing the cover into the form shown at B, Fig. 3. When making plate D, the four pieces are roughed out within 0.02 inch all over, then hardened and ground in a surface grinder, the wheel of which has been trimmed with a radial fixture to the convex shape of the required radius.

New York City

CHARLES HARDY

RIFLE CHAMBER REAMER

In the manufacture of rifles, the chamber reamer is a tool of prime importance. It must be as precise in its measurements as it is possible to make it; otherwise a quick, easy ejection, which is essential in a rifle, will be lacking. If the chamber should be reamed below its specified dimensions, the shell would jam and would not eject; if the chamber should be reamed too large, the shell would expand on explosion, and again the ejection would suffer. The reamer is made of high-grade tool steel. It differs from barrel reamers primarily in its shape, which, in the finishing reamer, is the shape of the cartridge. There are several different grades of chamber reamers, ranging from the first roughing reamer to the hand finishing reamer. The first roughing reamer is shorter than the finishing reamers and does not take a chip from the

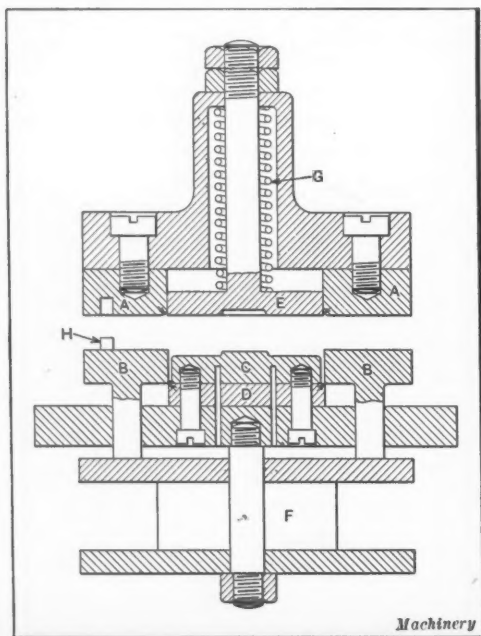


Fig. 2. First Punch and Die used in making Stamp Cover

entire length of the chamber, but merely cuts from the large or rear end, as it is there that the greatest amount of stock must be removed. It is this roughing reamer that cuts the biggest chip, and it has but four flutes, the edges

of which are cut across with a thread tool. There are about three of these cuts to the inch, and they serve to break up the chips, thereby feeding them out more rapidly. The finishing reamers have preferably a greater number of flutes, probably six or eight in number, and this increased number of flutes insures a smoother surface. An absolutely smooth surface is required, as a rough, uneven chamber would cause the shell to swell when exploded, and this, as before stated, would oppose a free ejection.

The total amount of stock removed by the chamber reaming in a 0.315-inch caliber rifle is 0.2362 inch. The first rough reaming takes away 0.2312 inch, and the remaining 0.005 inch is removed by the roughing and finishing operations that follow. By this may be seen the great difference in the size of the chips of the first rough-reaming and the following reamings. During the chamber reaming process the rifle barrel may be in either an upright or a horizontal position. In either case, the oil-flow that cools the tool enters the muzzle end of the barrel and is forced through to the other end. Although simple, the chamber reaming operation is very important; and

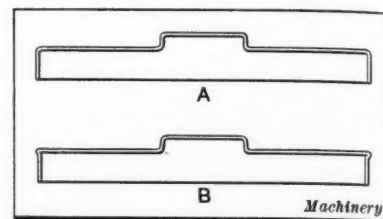


Fig. 3. Stages in making Stamp Cover

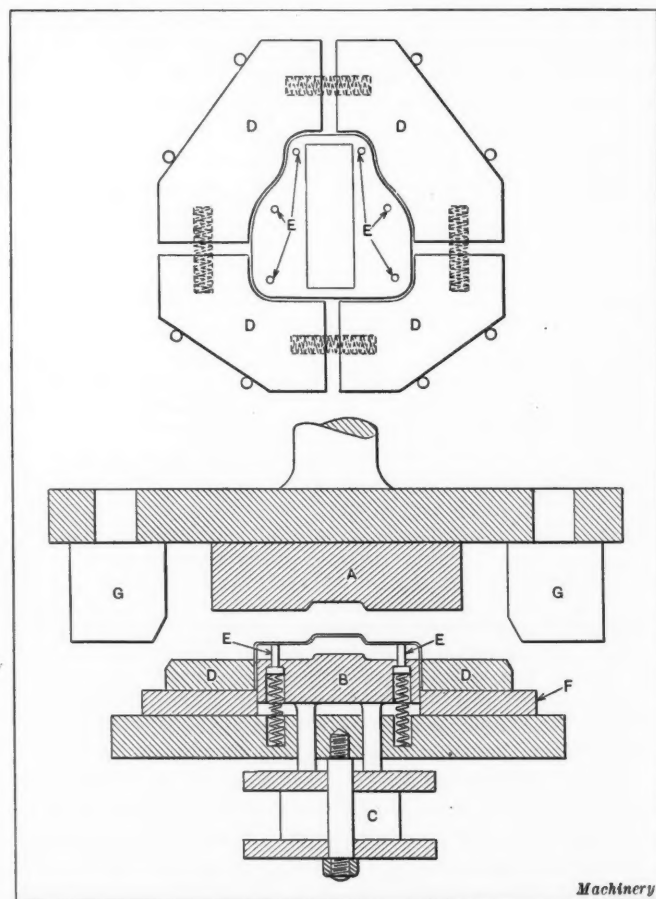


Fig. 4. Punch and Die used to complete Stamp Cover

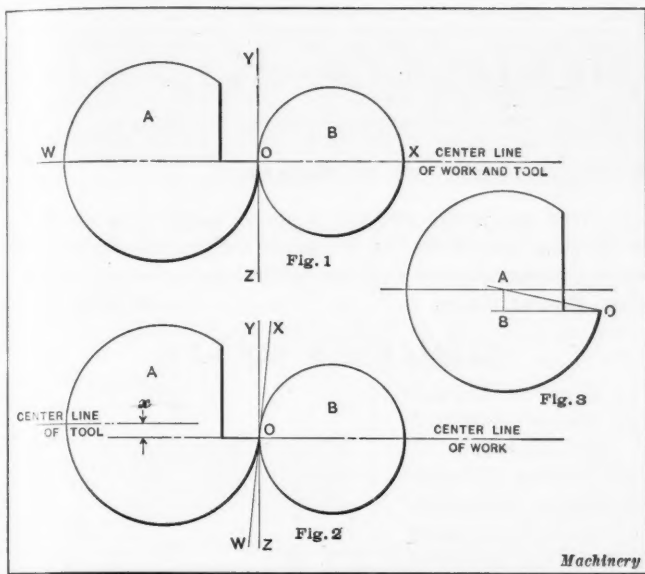
as the success of the operation depends upon accurately made tools, it will be seen that the chamber reamer is an instrument of great importance in the manufacture of rifle barrels.

West Haven, Conn.

HARRY W. CHARD

CLEARANCE OF CIRCULAR FORMING CUTTERS

I agree with Mr. Miller, in the December number, that a great deal of time is wasted in developing the curves of forming cutters of the circular type. In this connection it is of



Figs. 1 to 3. Diagrams showing Clearance of Circular Forming Cutters

interest to consider the importance of clearance, and for the purpose of making clear what I have to say, I will review the situation.

If an exact outline is to be obtained by the use of a circular forming cutter, the cutter must be formed to give the exact outline on its cutting edge and not on the diametral section. To illustrate this rule, in Fig. 1 let A be a forming cutter that has been formed to give an exact outline on its diametral section, and B the work. The cutter and the work are set at the same height, that is with the cutting edge of the cutter on the line WX passing through their centers. The work produced will be the correct shape, but the tool can cut only while it remains absolutely sharp because the cutter is given no clearance angle, since tangents to the work and to the cutter at point O coincide in the line YZ. The cutting edge, however, is strongest in this position and becomes weaker as the clearance angle increases, because of lack of metal directly beneath the cutting edge. This angle of clearance may range from 3 to 15 degrees, depending on the work and the material of which the cutter is made. In Fig. 2, the forming cutter A has been formed to give an exact outline on its cutting edge, which is a distance x below the center of the tool and is set

CLEARANCE ANGLES AND VALUES OF x OF FORMING TOOLS

Clearance Angle, Degrees	Diameter of Cutter, Inches				
	2	2.5	3	3.5	4
	Value of x , Inches				
3	0.052	0.065	0.078	0.091	0.102
4	0.069	0.087	0.103	0.110	0.138
5	0.087	0.109	0.130	0.150	0.174
6	0.104	0.130	0.156	0.182	0.208
7	0.122	0.152	0.183	0.212	0.244
8	0.139	0.173	0.208	0.241	0.278
9	0.156	0.195	0.234	0.273	0.312
10	0.174	0.217	0.261	0.303	0.348
11	0.191	0.239	0.286	0.335	0.382
12	0.208	0.252	0.312	0.365	0.416
13	0.225	0.281	0.337	0.393	0.450
14	0.242	0.302	0.363	0.422	0.484
15	0.259	0.323	0.388	0.451	0.518

in line with the center of the work B. This distance x is dependent on the clearance angle WOZ, which is formed by the intersection of the line YZ drawn tangent to the work and the line WX drawn tangent to the tool at O. In the accompanying table are given the values of x and the clearance angle for forming tools of given diameters. In the table the distance x is obtained by multiplying the radius of the cutter by the sine of the angle AOB, Fig. 3, or what is the same thing, the clearance angle.

Moline, Ill.

C. C. HERMANN

PROBLEM IN TRIGONOMETRY

Another comment on the "Problem in Trigonometry," on page 245 of the November number, is as follows: In any triangle, the product of two sides is equal to the product of the diameter of the circumscribed circle by the altitude upon the third side. Thus:

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$AB = \sqrt{3.125^2 + 7.25^2} = 7.8948 \text{ inches}$$

$$\text{Diameter of circumscribed circle} = \frac{8.4038 \times 7.8948}{7.25} = 9.1512 \text{ inches}$$

$$DC = \frac{9.1512}{2} = 4.5756 \text{ inches}$$

Indianapolis, Ind.

ROBERT W. SMITH

The geometrical construction given on page 245 of the November number of MACHINERY, for finding the center of a common gear for three pinions is simple and direct, but much of the accompanying computation is unnecessary. If the point of intersection of the vertical line through C and the horizontal line through B is denoted by H, as the point E bisects the line BC, the line EG is one-half of HC, or equal to $3\frac{5}{8}$ inches; and GC is one-half of BH, or equal to $2\frac{1}{8}$ inches. The triangles DEF and CBH are similar and their corresponding sides are proportional. Hence $\frac{EF}{DF} = \frac{BH}{CH}$; or $EF = \frac{BH \times DF}{CH}$.

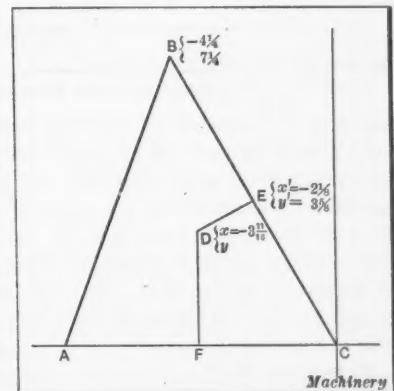
Now, $DF = BH - GC = 9/16$; or $DF = 4\frac{1}{4} - 2\frac{1}{8} = 9/16 = 19/16$. Therefore, $EF = \frac{4\frac{1}{4} \times 19/16}{7\frac{1}{4}} = 0.916$; whence $X = 3\frac{5}{8} - 0.916 = 2.709$.

Ampere, N. J.

A. A. NIMS

A simpler and more accurate solution of the problem stated on page 245 of the November number of MACHINERY is possible if analytical geometry is used.

Slope m' of BC = $-\frac{7\frac{1}{4}}{4\frac{1}{4}}$
 Slope m of DE = $\frac{4\frac{1}{4}}{7\frac{1}{4}}$
 Equation of line DE, $(y' - y) = m(x' - x)$
 $(3\frac{5}{8} - y) = \frac{4\frac{1}{4}}{7\frac{1}{4}}(-2\frac{1}{8} + 3\frac{11}{16})$,
 from which $y = 2.709$
 Hence $y = DF = 2.709$



Problem solved by Analytical Geometry

The above example illustrates how simple many problems may be made by using the principles of analytical geometry.

Newark, N. J.

ORMONDE BOBERT

RIGHT- AND LEFT-HAND TOOLS

In the December number of MACHINERY, R. L. decides that a tool gets its name of "right-hand" or "left-hand" from the side the cutting edge or inclination is on rather than from the side of the work it cuts. The writer thinks that a right-hand lathe tool would generally be considered a left-hand tool if used in a planer or shaper, as the tool is commonly fed from right to left, when the operator stands facing the front of the machine. Consequently, the tool gets its name from the direction of cut in the machine rather than from its own inclination or side of cut. To cut a right-hand thread the tool will be inclined to the left, but it would be hardly correct to speak of cutting a right-hand thread with a left-hand tool. In the case of a side tool for the lathe, a right-hand tool (as commonly called) will work on the right-hand end of the work, and a right-hand planer or shaper tool also will work on the right-hand side or end of the work.

East Bridgewater, Mass.

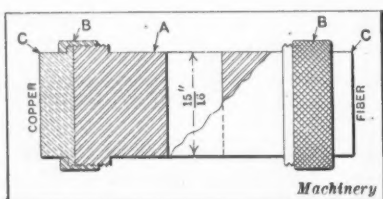
PERCY S. THOMAS

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

REMOVABLE HEAD HAMMER

The advantages of the soft hammer here illustrated are that



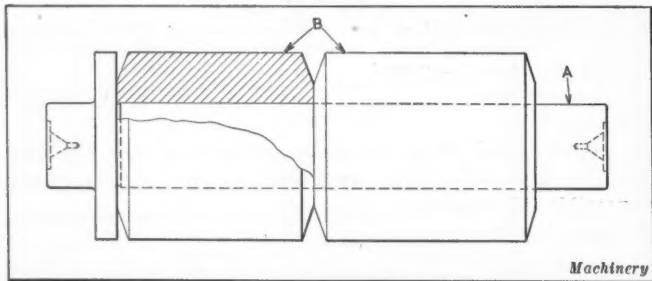
Soft Hammer with Removable Head

ends for the knurled nuts *B* which hold the heads *C* in place.
Ambridge, Pa. AUGUST J. LEJEUNE

AUGUST J. LEJEUNE

THREADING-TOOL SETTING ARBOR

The illustration shows a threading-tool setting gage that is similar to the one described in the October number of *MACHINERY*, except that it is hardened and ground. The advantage of this is that the V-point may be made sharper and the



Gage for setting Threading Tools

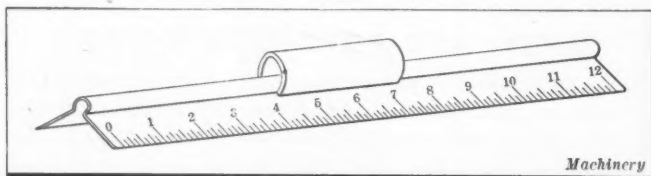
tool will not scratch or mar the gaging surface. The arbor body *A* may be made of tool steel, hardened and ground, or of cold-rolled steel, pack-hardened and ground. Bushings *B* are lapped to a snug fit on the arbor and are ground square on the ends, the bevels being ground while on the arbor. One end may be used for U. S. standard threads, while the other may be made for either Whitworth or metric threads. The end grinding of the bushings is done with the bushings projecting over the end of the arbor.

Watertown, N. Y.

HERBERT V. COULSTON

HANDLE FOR DRAFTSMAN'S SCALE

The scale shown in the illustration is familiar to all draftsmen or engineers. The handle is made from either brass or light-gage steel tubing, about $\frac{5}{8}$ inch diameter and $2\frac{1}{4}$ inches



Handle for Draftsman's Scale

long. The tubing is slotted the entire length by a hacksaw, and is snapped over the ridge of the scale into place.

Flint, Mich.

C. C. SPREEN

JIG LOCATING SYSTEM

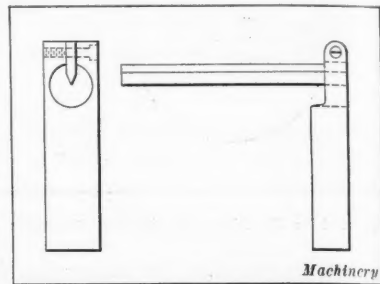
The writer suggests the following method of locating jigs, etc. The special tools, jigs and gages are separated into convenient groups, and each group is given a number. This number is stamped within a circle on each piece of the group and on the proper storage rack. Where the use of a jig or gage

is required, the group number is placed inside of a circle on the drawing, and when the workman studies the drawing he sees the group number and can easily locate the proper tool.

Los Angeles, Cal. R. H. WELCOME

DIEMAKER'S SQUARE

In filing the angular clearance on small dies, the square shown in the accompanying illustration permits the light to enter through the space cut from the inside of the beam, while the hole serves for a line of vision and allows the blade to be clamped at the necessary angles.



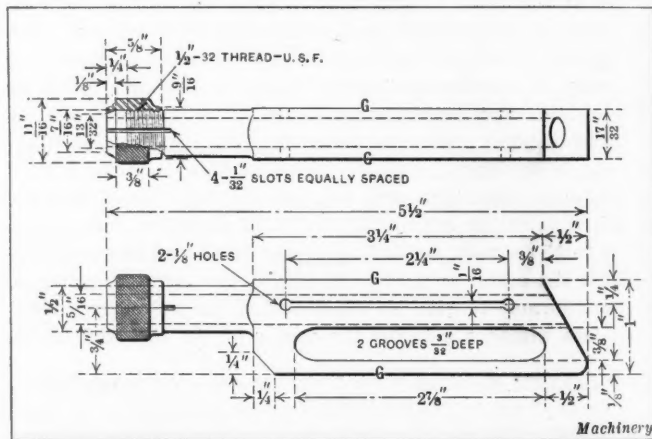
Handy Diemaker's Square

New York City

E. J. HIGGINS

TOOLMAKER'S BORING TOOL-HOLDER

The illustration shows a tool-holder that is superior to the old style of V-holders, most of which have a set-screw projecting over the tool that prevents using it close to a faceplate



Handy Boring Tool-holder for Toolmakers

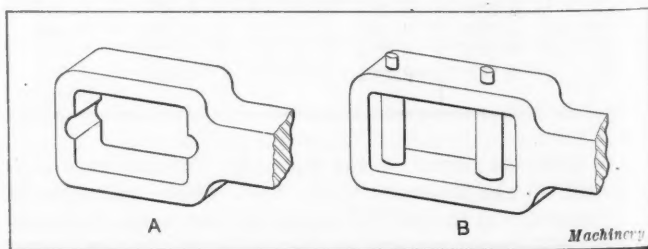
when the work is held by U-straps. The boring tool is made of 5/16-inch drill rod and is clamped by the toolpost screw. The knurled nut at the end prevents unnecessary spring by means of the taper and slots that are shown.

Frankford, Pa.

CHARLES W. CARVETTE

DURABLE BELT SHIFTER

Several belt shifters became worn at the sides, as shown at A in the illustration, and gave trouble by curling the edge of the belt when shifting. At B is shown the change that was



Change made in Shifter Design

made in the design. Two rollers are used for guides; these revolve when the belt touches them, and thus eliminate wear on the shifter and on the edge of the belt.

Concord, N. H.

CHARLES H. WILLEY

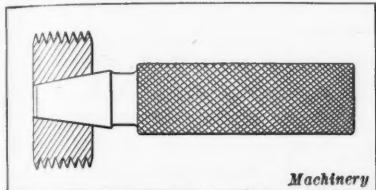
HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

ENLARGING WORN THREAD PLUG GAGES

In the January number of *MACHINERY*, D. D. inquires if there is any way of enlarging a thread plug gage that has worn small. This can be easily accomplished by designing the plugs as shown in the accompanying illustration. The taper plug is made of soft steel and is forced into the thread ring. After hardening the ring, the soft taper plug is forced into place by a screw press to enlarge the threads (which usually contract in hardening) for lapping. This plug may also be forced farther into the ring when the threads are worn small.

A CONSTANT READER



Method of enlarging Worn Thread Plug Gages

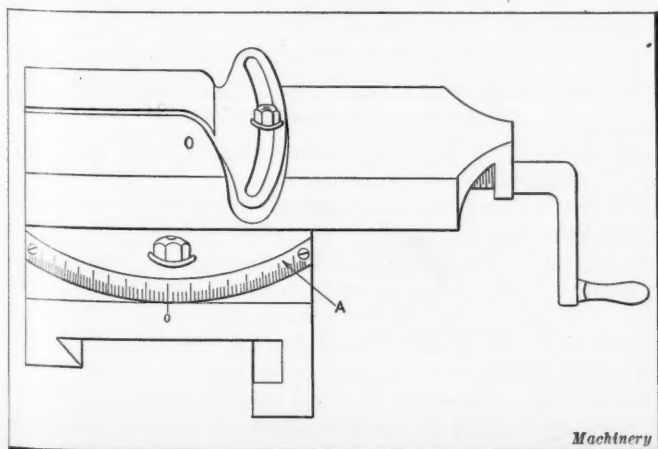
THREADING TAPS

C. E. C.—Is the following method of sharpening and lubricating taps in general use? It seems to be opposed to the teaching of the Pratt & Whitney Co. that resharpening should be done entirely on the face of the tap. The method has been used on taps working in soft steel, with a water solution of soluble oil, and on sizes from 5/16 to 3 inches, with fine threads. The taps are threaded with the cutting end about 0.002 inch large, fluted and relieved with a three-cornered Swiss file to within about 1/32 inch of the cutting edge. When hardened and drawn in oil, they are placed between centers in the universal grinder and the chamfer ground to include four threads on the smaller sizes and six on the larger. As this gives no clearance on these ends, the clearance is obtained by feeding the tap in from 0.005 to 0.008 inch on the cross-feed handle and turning the tap by hand until all but 1/32 inch of the previously ground surface has been removed, the piece being taken from the centers between each flute. The larger sizes are lubricated by having a 1/4-inch hole drilled entirely through them. The releasing holder is connected to the pump, so that the solution is forced through this hole ahead of the tap, returning through the flutes.

This question is submitted to the readers for discussion.

GRADUATING A PLANER HEAD

In the January number of *MACHINERY*, a correspondent asks how a planer head may be graduated in a shop that has no special appliances. The writer would suggest that the diameter of the part to be graduated in the accompanying illustration be multiplied by 3.1416, and this product divided by 360; the result will be the distance apart the graduations should be.



Method of graduating a Planer Head

These graduations may then be marked on a thin narrow strip A of cold-rolled steel, which is afterward fastened to the head as shown. For instance, if the diameter should be, or could be made to be, 14 21/64 inches, a flexible scale graduated to 1/8 inch will do the trick, as $14 \frac{21}{64} \times 3.1416 \div 360 = 0.125$.

Somerville, Mass.

JOHN R. BECKETT

PROBLEM IN GEOMETRY

A. B. C.—Prove that in any triangle the product of two sides is equal to the product of the diameter of the circumscribed circle and the altitude upon the third side.

A.—Referring to the illustration, it is desired to prove that $AB = \text{diameter} \times H$.

$$\text{The area of the triangle} = \frac{AB \sin \alpha}{2}$$

Therefore, we will prove that

$$\frac{AB \sin \alpha}{2} = \frac{DH \sin \alpha}{2}, \text{ or } RH \sin \alpha$$

If an angle at the circumference of a circle, between two chords, is subtended by the same arc as the angle at the center, between the two radii, then the angle at the center equals two times the angle at the circumference, so $\beta = 2\alpha$.

The area of a triangle equals one-half the base times the altitude.

$$1/2 C = R \sin \alpha$$

$$\text{Area} = R \sin \alpha H$$

$$\text{Thus: } \frac{AB \sin \alpha}{2} = RH \sin \alpha$$

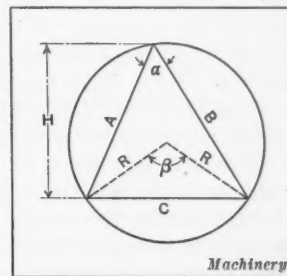


Diagram illustrating Problem in Geometry

CROWNING OF LOOSE PULLEYS

F. M.—(1) Is it customary to make drop-face or reduced-diameter loose pulleys with a crowned face? (2) Are cone step pulleys made with crowned face?

A.—(1) A number of replies have been received to this question. In the opinion of the Hall & Brown Woodworking Machine Co., St. Louis, Mo., all pulleys where the belt is to run in a fixed position for a period of time should be crowned, as this will hold the belt in position better. A belt running on a loose pulley having a straight face is likely to run against the edge of the tight pulley, and even to climb onto the pulley in spite of the fact that the loose pulley is made with a reduced diameter. The Defiance Machine Works, Defiance, Ohio, state that it is their practice to crown all loose pulleys. The American Woodworking Machinery Co., Rochester, N. Y., follows the same practice, but also advises that it has discontinued the use of loose pulleys with reduced diameters on account of the effect upon the belt, which is stretched on the side running against the flange between the loose and tight pulley. The only advantage of the reduced-face pulley is on countershafts which are placed quite close to the lineshaft and where a short tight belt is used. When the belt is shifted from the tight to the loose pulley some of the strain is taken off the loose pulley bearing, thus giving it longer life, if that pulley is made with a reduced diameter. The H. B. Smith Machine Co., Smithville, N. J., states that in this company's practice loose pulleys with reduced diameter are made with a straight face. The Bentel & Margedant Co., Hamilton, Ohio, also makes it a practice to provide drop-face loose pulleys with a straight face, but crown

slightly loose pulleys that are of the same diameter as the tight pulley. The J. A. Fay & Egan Co., Cincinnati, Ohio, states that drop-face loose pulleys are provided with a crowned face, in the company's practice, because unless so made the edge of the belt runs against the bevel flange and has a tendency to climb onto the tight pulley and start the machine without the operator's knowledge. The company, however, discourages the use of drop-face loose pulleys, because they are very hard on the belts. The elimination of the drop-face loose pulley, also known as the "bevel-flange pulley," would mean considerable economy on account of the belt cost.

(2) Cone step pulleys are crowned the same as other pulleys of corresponding size.

FINDING THE AMOUNT OF METALS IN AN ALLOY

O. O. T.—We have an alloy that is known to contain copper, tin and zinc, and, by careful weighing, it has been found that a cubic inch weighs 0.285 pound. Is there any way by which we can find the proportions of copper, zinc and tin without making an analysis?

A.—Problems of this kind belong to the class called indeterminate; they are so called because they are capable of an indefinite number of solutions. However, by imposing certain restrictions, a satisfactory solution may usually be obtained. In the present case, it is assumed that the density of the alloy is directly proportional to the densities and amounts of the metals composing it. By this is meant that there is not a chemical combination, as in the case of carbon and iron in steel, the density of steel being greater than iron, although the density of carbon is less than iron. It is also assumed that the number of parts of each metal is integral and less than 10. With these assumptions granted, the easiest way to solve problems of this kind is by the arithmetical process known as alligation alternate. Referring to page 1245 of MACHINERY'S HANDBOOK, it is found that the weight of one cubic inch of copper is 0.3184; of zinc, 0.2476; and of tin, 0.2632. Taking the weight of a cubic inch of the alloy as 0.2850, and dropping the decimal points, arrange these quantities as shown herewith. Subtract (algebraically) each num-

$$\begin{array}{r}
 2850 \left\{ \begin{array}{l} 2476 \\ 2632 \\ 3184 \end{array} \right. \left\{ \begin{array}{l} 374 \times 3 = 1122 \\ 218 \times 1 = 218 \\ -334 \times 4 = -1336 \end{array} \right. \left\{ \begin{array}{l} 1340 \\ -1336 \\ \hline 4 \end{array} \right.
 \end{array}$$

ber from the mean number 2850 and write the results, as shown, in the same rows as the corresponding subtrahends; note that two of these remainders are positive and the other is negative. Multiply these remainders by such numbers (to be found by trial) as will make the sum zero, or approximately zero. In this case, the multipliers are 3, 1 and 4, and their sum is 8. It is, therefore, assumed that in eight parts of the alloy there are three parts zinc, one part tin and four parts copper. Expressed in percentages, the alloy contains copper, 50 per cent; zinc, 37½ per cent; tin, 12½ per cent.

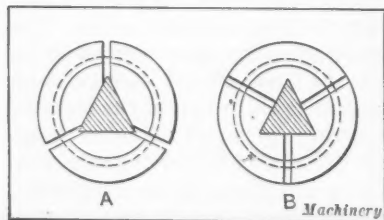
$$\text{Proof: } \frac{0.2476 \times 3 + 0.2632 \times 1 + 0.3184 \times 4}{8} = 0.28495,$$

which is very nearly 0.285 and coincides with it when reduced to three significant figures.

J. J.

WHICH WAY IS CHEAPER?

The proper way to make the chuck shown in the December number on page 348 under the head "Which Way is Cheaper?"



Two Ways of slitting Spring Chucks
stronger broach, but makes a better spring chuck.

Boston, Mass.

JOHN SHAND

By slitting as shown at A in the illustration in the December number not only is the risk of cracking in hardening eliminated, but accurate chucking on burred stock is secured; the latter fact is often overlooked by makers of hexagon and triangular collets. On soft stock where the chucking pressure is great enough to indent the stock, the method shown at B will be of greater advantage. Assuming the stock to be soft steel or brass, collets slit as shown at A will undoubtedly give more accurate results.

A quick way of slitting collets in three parts is to draw out of mesh the worm in a regular index head, and index from the jaws of the three-jaw chuck. This method means no extra equipment. It has been used by the writer on various collet and bushing jobs with good results.

Toronto, Ontario, Canada

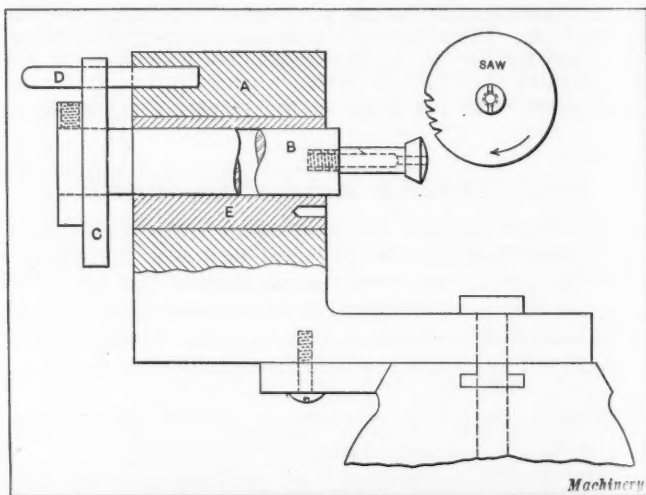
A. F. OWEN

In the December number of MACHINERY R. G. shows two spring chucks for triangular stock and asks which is the cheaper method of slitting. If he is making these chucks on order and the only requirement is that the chuck shall have three slots in the stock-holding end, there would probably be little, if any, difference in the cost of the two methods. However, if he is in any way responsible for the satisfactory performance of these chucks, he should by all means use the method shown at A. A chuck split as shown at B must have a relief groove in each corner, as the triangular stock will have occasional dents and burrs on the sharp corners. The cutting of these relief grooves will mean an extra cost, whereas the other method eliminates the sharp corners entirely. No matter if the stock being operated on is slightly misshapen, that is, not a true equilateral triangle, the chuck shown at A will grip it with all three prongs, while only a slight difference between the shape of the stock and the triangular hole of chuck B will result in but two jaws, or prongs, doing all the gripping.

Anderson, Ind.

LEROY M. CURRY

In the December number of MACHINERY, R. G. asks which is the cheaper and better method of slitting taper spring chucks. The chuck shown at A in the illustration in the December number is slit correctly, as it allows the corners of the stock to protrude into the slots and holds the work by the flat sides; as dirt and chips will collect in the corners of the



Slitting Fixture for Taper Spring Chucks

chuck shown at B, this chuck cannot grip the work properly; but one method is as cheap as the other.

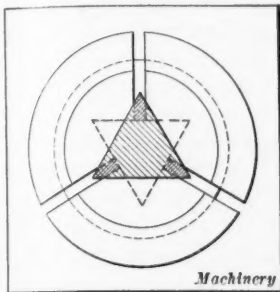
The best slitting fixture for spring chucks where the quantity of work to be produced warrants the expense of manufacture is shown in the accompanying illustration. The fixture is fastened to the bed of a bench lathe in place of the slide-rest. The saw is held in the head of the bench lathe. The casting A is drilled and reamed for the chuck-holder B, on the end of which is a cast-iron index plate C, having three holes that fit over a pin D. Vertical adjustment is provided by an eccentric bushing E. As R. G. does not show a side view of the chuck, it is impossible to show a proper holder, but the wire chuck shown will perhaps suggest some similar scheme

of holding the work. This method of sawing by pushing the work against the saw will be found more sensitive than a screw feed, as the least catching of the saw will be felt at once and the work can be withdrawn before the saw is broken. A stiff bristle brush, such as a toothbrush, dipped in cutting oil, should be rubbed constantly across the teeth of the saw.

Jersey City, N. J.

W. H. DUNBRACK

It is clearly seen in the accompanying illustration, where method A is shown in full lines, and method B in dotted lines, that the first is the cheaper. In the first case there is not as much stock to be removed when milling the slits as by the other method. Also, the slits are not as deep, so the time and the power necessary for removing the stock shown in shaded lines are saved, with the resulting reduction in the cost. Of course, the operations in each case are the same, namely, after the piece has been finished on the outside and broached, it is slit on the milling machine.



Two Methods of Slitting Taper Chucks

While method A is the cheaper, method B is preferable, as the slits should always come on the sides of the stock.

Cincinnati, Ohio

TAFT S. ARMANDROFF

INSPECTION LIMITS FOR TAPS AND DRILLS

Q. R.—What are the generally used limits for taps and drills as sold in the open market?

A.—There is no universal agreement among manufacturers of taps and drills as regards the limits to be used for these tools. All taps are made over size both on the outside diameter and the pitch diameter, the size that would pass inspection being somewhere between standard nominal size and the over-size limit adopted. In Table 1 are given these over-size limits for hand taps and taper taps. This table places on record the average limits used by two tap manufacturers and may be assumed as representing good practice. As the outside diameter is not vital to the size of thread cut by the tap, this being determined by the pitch diameter, the dimensions given in the table for outside diameter limits need not be so strictly adhered to (provided the diameter is always larger than nominal) as those for pitch diameter limits. The over-size dimension on the outside diameter provides for clearance and wear, and, in fact, many makers permit much larger limits than those given.

The permissible error in lead (in ordinary single-threaded taps the lead equals the pitch) should be ± 0.002 inch in 1 inch length of thread. Taps on the market, however, indicate that this limit is not adhered to by all makers, as taps of several makes that have been measured have proved to have a lead error of as much as 0.006 inch. Only a few makers seem even to attempt to limit the lead error to 0.002 inch.

On taps where great accuracy is required, as, for example, for hob taps used for finishing threading dies, the limits should be made from 0.00025 to 0.0005 inch less than the limits given for hand taps in Table 1 for the finer pitches, and about 0.001 inch less than the limits given for the coarser pitches. This

also applies to taps made to the Society of Automotive Engineers' standard (S. A. E. standard). The limits in the table are given for "number of threads per inch," which has been found to be rational and much better than when an attempt is made to give the limits for

TABLE 1. INSPECTION LIMITS ON TAPS

Maximum Limit: Figures given in Table added to Standard Nominal Diameter. Minimum Limit: Standard Nominal Diameter

Number of Threads per Inch	Hand Taps		Taper Taps	
	Outside Diameter	Pitch Diameter	Outside Diameter	Pitch Diameter
80	+ 0.0012	+ 0.0007	+ 0.0025	+ 0.0020
72	+ 0.0014	+ 0.0010	+ 0.0027	+ 0.0022
64	+ 0.0015	+ 0.0011	+ 0.0030	+ 0.0025
60	+ 0.0016	+ 0.0012	+ 0.0033	+ 0.0028
56	+ 0.0017	+ 0.0013	+ 0.0035	+ 0.0030
48	+ 0.0018	+ 0.0014	+ 0.0037	+ 0.0032
44	+ 0.0019	+ 0.0015	+ 0.0038	+ 0.0033
40	+ 0.0020	+ 0.0016	+ 0.0039	+ 0.0034
38	+ 0.0021	+ 0.0017	+ 0.0040	+ 0.0035
36	+ 0.0021	+ 0.0017	+ 0.0041	+ 0.0036
34	+ 0.0022	+ 0.0018	+ 0.0042	+ 0.0037
32	+ 0.0022	+ 0.0018	+ 0.0043	+ 0.0038
30	+ 0.0023	+ 0.0019	+ 0.0044	+ 0.0039
28	+ 0.0023	+ 0.0019	+ 0.0045	+ 0.0040
26	+ 0.0024	+ 0.0020	+ 0.0046	+ 0.0041
24	+ 0.0024	+ 0.0020	+ 0.0047	+ 0.0042
22	+ 0.0025	+ 0.0021	+ 0.0048	+ 0.0043
20	+ 0.0026	+ 0.0022	+ 0.0049	+ 0.0044
18	+ 0.0027	+ 0.0023	+ 0.0050	+ 0.0045
16	+ 0.0028	+ 0.0024	+ 0.0051	+ 0.0046
14	+ 0.0029	+ 0.0025	+ 0.0053	+ 0.0048
13	+ 0.0031	+ 0.0027	+ 0.0055	+ 0.0050
12	+ 0.0032	+ 0.0028	+ 0.0057	+ 0.0053
11	+ 0.0033	+ 0.0029	+ 0.0059	+ 0.0056
10	+ 0.0035	+ 0.0030	+ 0.0060	+ 0.0057
9	+ 0.0037	+ 0.0032	+ 0.0062	+ 0.0058
8	+ 0.0040	+ 0.0034	+ 0.0064	+ 0.0060
7	+ 0.0044	+ 0.0036	+ 0.0066	+ 0.0062
6	+ 0.0048	+ 0.0039	+ 0.0068	+ 0.0064
5	+ 0.0052	+ 0.0043	+ 0.0070	+ 0.0066
4	+ 0.0058	+ 0.0045	+ 0.0075	+ 0.0070

Machinery

certain diameters with corresponding number of threads only.

With regard to limits for drills, the principle is reversed. Drills must never be permitted to have dimensions over the nominal standard diameter. If they were, they would not enter drill jig bushings of standard size, and, furthermore, a drill, no matter how carefully ground, generally will drill a hole that is slightly larger in diameter than the size of the drill. Hence all drills should be between a limit less than the standard nominal size and the nominal size. For example, a 1-inch drill should be between 0.999 inch and 1.000 inch. The limits for drills of all classes are given in Table 2.

* * *

Broaches are displacing reamers quite generally in manufacturing where it is necessary to finish many holes to the same diameter for a push, drive or running fit. The broaching process is much more rapid than reaming, and, moreover, the broach stands up for many times the number of holes that a reamer will finish before becoming very dull. The Robbins & Myers Co., Springfield, Ohio, uses a novel form of broach for sizing holes in a part that is a push fit in armature construction. The broaches are made of high-speed steel, and instead of having the teeth formed by parallel circumferential grooves, they are formed by cutting a helix or thread of buttress shape. The broach is sharpened by grinding the top of the teeth and tapering the broach so that the leading end is a few thousandths of an inch smaller than the rear

end. Of course, the backs of the teeth drag in the hole, as there is no cutter clearance, but this defect seems to be of little practical importance, as the broaches do good work and size thousands of holes before they have to be reground to a smaller size.

TABLE 2. INSPECTION LIMITS FOR TWIST DRILLS

Maximum Limit: Standard Nominal Diameter. Minimum Limit: Figures given below subtracted from Standard Nominal Diameter

Sizes of Drills, Inches	Value for Finding Minimum Limit, Inch	Sizes of Drills, Millimeters	Value for Finding Minimum Limit, Inch	Sizes of Drills, Number or Letter	Value for Finding Minimum Limit, Inch
$\frac{3}{32}$ to $\frac{1}{16}$	-0.00025	0.5 to 1.75	-0.00025	No. 80 to No. 50	-0.00025
$\frac{1}{16}$ to $\frac{1}{8}$	-0.0005	1.8 to 6.3	-0.0005	No. 49 to No. 1	-0.0005
$\frac{1}{8}$ to $\frac{1}{4}$	-0.00075	6.4 to 13	-0.00075	A to D	-0.0005
$\frac{1}{4}$ to $\frac{3}{8}$	-0.001	13.5 to 32	-0.001	E to Z	-0.00075
$\frac{3}{8}$ to $\frac{1}{2}$	-0.0015	32.5 to 50	-0.0015	.....	.....
$\frac{1}{2}$ to 1	-0.002	50.5 to 75	-0.002	.....	.....

Machinery

FORMULAS FOR COMBINED BENDING AND TORSION

The subject of combined bending and torsion is one that has proved more confusing to machine designers than any other phase of the strength of materials that is ordinarily encountered by the mechanical engineer engaged in ordinary machine design. Several formulas have been proposed, but unless they are used with a thorough understanding of their limitations, mistakes are likely to be made. Prof. A. Lewis Jenkins of the University of Cincinnati, in a paper presented before the annual meeting of the American Society of Mechanical Engineers in December, 1917, thoroughly analyzes the subject and gives formulas which may be directly applied by machine designers when the bending moment, the twisting moment and the permissible working stress are known. Two formulas are given, one for the design of shafts of brittle materials and one for soft ductile materials.

The following formula, known as the Grashof formula, may be used for the design of shafts and similar machine parts constructed of brittle materials, such as cast iron, hardened or annealed tool steel, hard bronze, and other materials having a small contraction of area when tested in tension:

$$SZ = 3/8M_b + 5/8 \sqrt{M_b^2 + M_t^2}$$

in which S = permissible or working stress in tension;

Z = rectangular (ordinary) section modulus;

M_b = bending moment to which member is subjected;

M_t = torsional moment to which member is subjected.

For the design of parts made of soft or ductile materials, such as mild (low-carbon or machine) steel, copper, soft brass and soft steel tubing, the following formula should be used:

$$S_p Z_p = 1.3 \sqrt{M_b^2 + M_t^2}$$

in which Z_p = polar section modulus;

S_p = permissible or working stress in shear, the notation otherwise being the same as above.

The accompanying table gives values for the unit tensile and unit shearing stresses at the yield point, of a number of different materials. By using a suitable factor of safety, the permissible working stresses may be obtained from this table.

STRESSES AT YIELD POINT OF DIFFERENT MATERIALS

Material	Average Tensile Stress per Square Inch at Yield Point	Average Shearing Stress per Square Inch at Yield Point
Machine steel (mild carbon steel) . .	47,000	30,000
Rivet steel	39,000	24,000
High-carbon steel	60,000	27,000
Nickel steel	70,000	37,000
Steel tubing	22,000	13,000

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If these two formulas are generally used when applicable, the Guest formula, the use of which has been often advocated during recent years, will be found unnecessary; it would perhaps be desirable if this formula were not so generally advocated, because it applies only to ductile materials, and if used for hard or brittle materials, would lead to the adoption of unsuitable dimensions.

* * *

The Davis Mfg. Co., Milwaukee, Wis., has developed a continuous rotary table milling machine with accelerated feed motion which automatically goes into action when the cutter has finished a piece. The lost time on the "wind cut" is thus reduced. A hob was required to hob the worm-wheel, and Mr. Davis ordered an inserted-tooth hob made, as he believed, so that it would serve the purpose as well as a solid hob and would be much cheaper in labor and material cost. The body was turned from carbon tool steel and holes were drilled in a helical path for 9/16-inch high-speed steel plugs. The plugs were shaped approximately to the required hob tooth shape and driven into place. The assembled hob was then chased and the teeth backed off in regular fashion and hardened. No trouble was experienced because of cutters loosening in the body, the shrinkage of the tool steel and high-speed steel being practically the same.

PERMANENT MOLDS FOR SHELL CASTING

In a paper presented before the American Foundrymen's Association, E. A. Custer, the inventor of the Custer process for casting in permanent molds, which was described in detail in MACHINERY, May, 1911, dealt with the possibilities of casting shells in permanent molds.¹ There is nothing new in the use of cast-iron projectiles, as before the present steel age they were the sole means of battering down defenses and of attack at long range. Some of the reasons why the use of cast-iron shells was abandoned are that the metal has never made a very good record for uniformity, freedom from sponginess and gas-holes; its tensile strength is low, and it lacks toughness. The defects commonly found in cast iron will seriously affect the trajectory and direction of a shell and render it comparatively useless. If one portion is spongy, and hence lighter than the remainder, it will wobble in its flight and its main purpose will be destroyed. The weakening effect of sponginess or blow-holes may cause the shell to break under the impulse of discharge, and destroy the gun. A forged steel projectile meets all these objections, and for that reason has been universally adopted.

As early as May, 1913, German and Italian munition makers were discussing the manufacture of cast-iron projectiles. In August, 1913, it was reported that shells had been made that were satisfactory, in that they had the proper degree of fragmentation and were strong enough to resist the effect of the propelling charge. These shells were made in iron molds with iron cores. Their peculiarly destructive effect was later observed in the field, not only in the open, but also against earthworks, and the then prevalent idea that the German forces were using cast-iron shells on account of the scarcity of steel was abandoned. Ordinary foundry iron, when properly cast in a permanent mold and when removed at the proper time, has in the resultant casting the same degree of hardness, irrespective of any variation in the chemical constituents, so long as the same size, weight and shape of casting is made. The time the casting remains in the mold is the determining factor. A casting weighing about 60 pounds remains in the mold 4 or 5 seconds, while a casting of the same general contour weighing 500 pounds will require 25 to 60 seconds.

The low cost and great output per day and effectiveness of cast-iron shells have been so completely recognized that two of the warring nations are using them to an enormous extent. France is casting them in sand, and Germany, from the best information available, is casting them in permanent molds. A steel forging for a 4.7-inch shell costs over \$7 at the present writing, while a casting of the same shell can be made for a little over \$2. Furthermore, a liberal saving in labor and machine-tool consumption can be effected.

* * *

REPEAL OF INCREASED SECOND-CLASS POSTAGE URGED

It is expected that Congress, during the present session, will repeal that part of the War Revenue Law passed last October which provides for an increase of from 50 to 900 per cent in the postage for periodicals, a matter that is of vital interest to all readers of mechanical and trade journals. Under the proposed zone system for second-class mail, it would cost 21 cents to send a copy of MACHINERY to Chicago, and proportionately more to send it to places farther away. It is quite evident that this is a prohibitive rate, when subscribers pay less than 20 cents a copy for their paper. Any readers of mechanical journals who are interested in maintaining the present usefulness of the engineering press could serve their trade or profession in no better way than by writing their congressman asking the repeal of the zone system for second-class mail. Particularly now, when the winning of the war depends to so great an extent upon the mechanical industries, it seems to be a very inopportune time to do anything that will throttle the spreading of useful information in these industries, and thereby hamper, to a considerable degree, the successful production of war materials.

¹ See also MACHINERY'S ENCYCLOPEDIA, Volume II, page 20.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

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HOLZ PERMEAMETER FOR MAGNETIC-MECHANICAL ANALYSIS OF IRON AND STEEL

RESEARCH work done abroad and at the U. S. Bureau of Standards has shown that the magnetic properties of iron and steel afford a most valuable index to the structural conditions existing in such materials, which is of special importance in those materials intended for use where strength or cutting properties are the essential factors. Not only do the initial processes of manufacture affect the magnetic characteristics, but subsequent heat-treatment also. Therefore, the magnetic test offers means of examining materials, tools, etc., during and after manufacture, without injuring or marring them, with a view to predetermining their mechanical performance. It also presents a method of investigating the "exceptional tool" or product, looking toward its routine duplication. In nearly every plant it happens that—by a combination of circumstances—a tool of remarkable quality, otherwise not distinguishable, is sometimes turned out which stands up far better than the average run of the product. It is, of course, important to obtain data to enable duplication of this high quality, and by the method of "magnetic-mechanical analysis" we are in a position to ascertain the characteristics of the remarkable product, so that a basis is created for its exact

Research work of scientists in this country and Europe has shown conclusively that there is only one set of mechanical characteristics corresponding to a given set of magnetic characteristics, and vice versa. Consequently, the magnetic properties of iron and steel give valuable information concerning structural conditions existing in the material. Until recently, this method has found little practical application in industrial plants owing to the difficulty of accurately determining the magnetic properties, but this difficulty has now been overcome through the development of the Holz "permeameter." This instrument may be used for testing milling cutters, reamers, twist drills, files, etc., and also for testing such products as wire, wire rope, drill rod, etc. An advantage of the method is that the entire piece is tested instead of a sample, and the test is made without in any way damaging the product, so that this method is equally applicable for use on raw materials and finished work.

for Testing Materials, the U. S. Bureau of Standards, and a number of private investigators are actively engaged on this important work, so that the science of properly correlating the underlying factors will surely make rapid progress in the near future, especially since accurate and convenient apparatus

duplication. The method of "magnetic-mechanical analysis" is based upon the fundamental fact that "there is one, and only one, set of mechanical characteristics corresponding to a given set of magnetic characteristics, and conversely there is one, and only one, set of magnetic characteristics corresponding to a given set of mechanical characteristics." The International Association for Testing Materials, the American Society

has now been developed to permit the practical application of this method of analysis in the industries. There are many advantages of "magnetic-mechanical analysis" which are of great importance. The material actually entering into the construction of the finished product and, in most cases, the final product itself can be subjected to the test without suffering the slightest injury. The various methods of testing now largely used (chemical, micro-

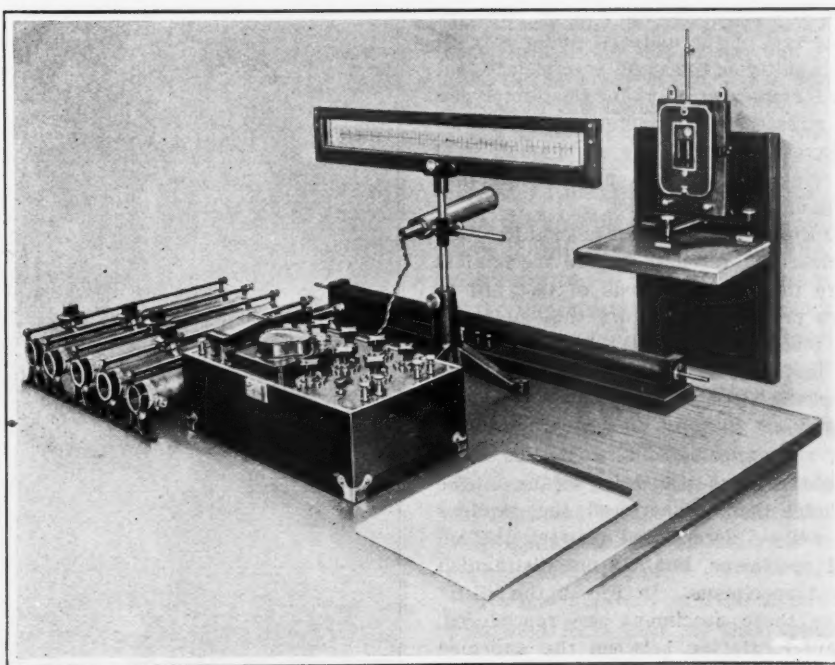


Fig. 1. Apparatus for Investigation of Mechanical Properties of Iron and Steel Wires, Ropes, Rods, etc., by Determination of their Correlated Magnetic Characteristics

¹From "Correlation of the Magnetic and Mechanical Properties of Steel," Scientific Paper No. 272, published by the U. S. Bureau of Standards, Washington, D. C.

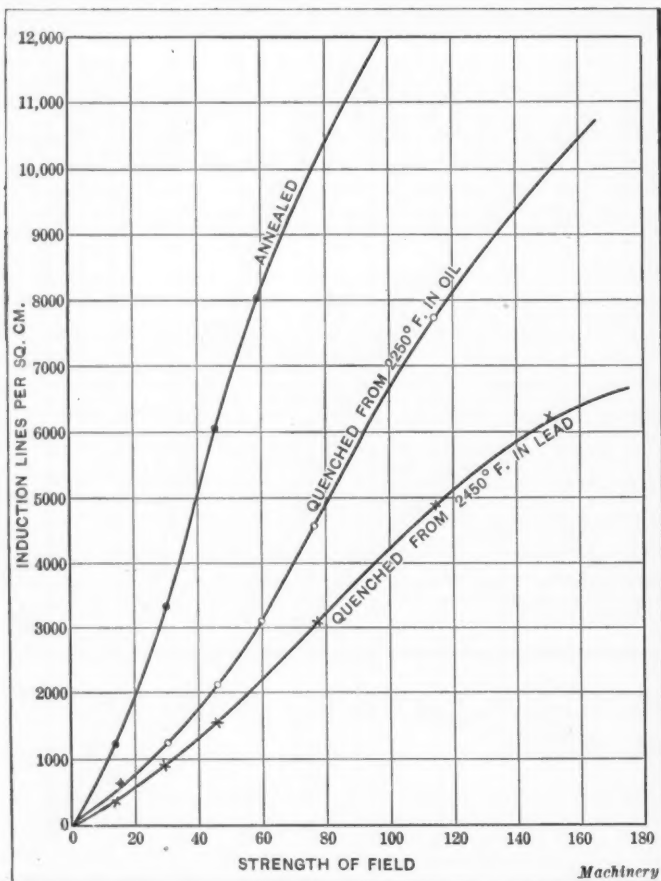


Fig. 2. Permeability Curves of Heat-treated High-speed Steel

scopic, hardness, tensile, impact, etc.) are either destructive or local surface tests. As Dr. Henry M. Howe says:¹ "Our tests destroy the part tested. That is a crude state of the art of testing. A wholly different line of testing from that now employed is opened by these magnetic investigations; that is to say, the reaction of the material to forms of energy which have no permanent effect on the material itself. . . . I do believe that we need radically different methods of testing; that our present methods are those of a crude, ignorant age, and will give way in time to radically different methods of testing which determine the reaction of the substance to forms of energy which do not injure the substance." Besides the point of destruction emphasized by Dr. Howe, the important question of "sampling error" enters into all the old methods of chemical and physical tests. As the science of testing stands now, we are pulling to destruction a bar of steel or piece of wire and presume that the rest of the material under investigation is exactly the same quality as the small specimen tested. We cut off a piece of steel for observation under the microscope and relieve the internal stresses in the metal, which are an important factor in the investigation. We press a small steel ball into a spot of a forging, casting, etc., and assume that this gives us the hardness of the entire mass.

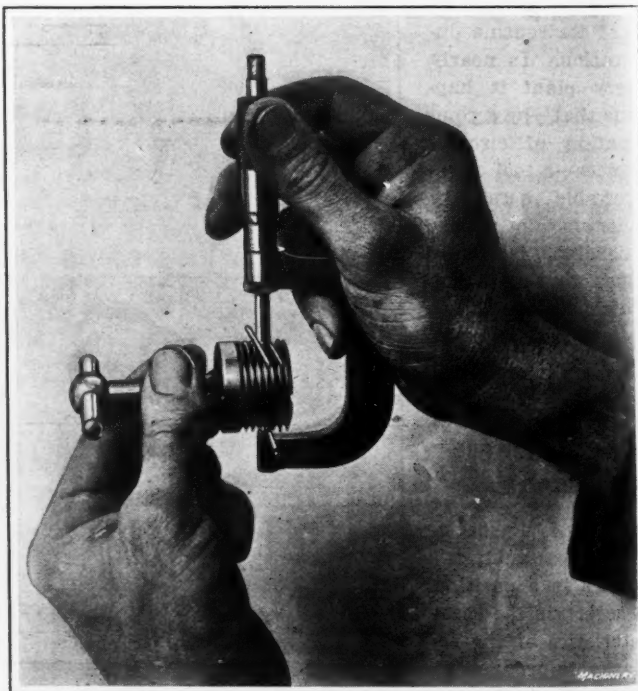
Another important feature of the magnetic-mechanical test is that it shows quite clearly differences in the mechanical properties of steel, where the other methods of test fail to indicate them, and where practice has shown that such differences do exist. Two pieces of steel may have the same "Brinell hardness," for instance, and still possess entirely different mechanical characteristics. This point was shown by R. P. Devries, who states:² "I wish to call attention to three specimens of steel, one annealed and two in the hardened condition. These pieces were tested by means of the Brinell hardness test, notch bar impact and the Martens scratch test. The tests easily differentiated between the annealed and the hardened specimens, but did not distinguish between the two hardened specimens. In Fig. 2 the "B-H" (permeability) curves for these specimens are reproduced. They indicate that by differentiating between the annealed

and the hardened state the magnetic test also discloses considerable differences between the two hardened specimens which the mechanical tests do not show." The magnetic-mechanical test is not restricted to work in the laboratory. Products like tools, saw blades, drills, ball bearing races, milling cutters, etc., can be subjected to routine tests in the plant, and in case some of these show distinct differences in magnetic properties against the average run, it is safe to assume that something is wrong with their mechanical properties, so that "seconds" can be easily separated and the quality of tools of established trademark can be at all times fully maintained. Among the many other steel products which readily lend themselves to this method of test are files, knives, drill rods, wires and wire ropes, springs, steel balls, plates, sheets, strips, etc. Fig. 1 shows a typical outfit for magnetic-mechanical analysis of wires, wire ropes and rods, and this apparatus is of considerable importance at this time for testing the wires used in airplane construction. Not a "specimen" of the material is subjected to the test, but the wires and cables actually entering into the construction of the planes. The slightest lack of homogeneity or otherwise invisible defects in the stranded wires are clearly shown up and danger is thus prevented. Similar tests can be applied to elevator and hoisting cables; in such cases the apparatus is mounted permanently and defects can be detected before accidents happen.

The main reason why this important method has not found considerably wider practical application heretofore was the difficulty in the operation of the instruments which had been available for conducting magnetic tests. Considerable progress was made by the development of the "Fahy" permeameter, fully described in Scientific Paper No. 306 of the U. S. Bureau of Standards, Washington, D. C., which has already found application in the industry for conducting magnetic-mechanical tests. Further progress has recently been made in the design of such apparatus by the development of a still simpler and just as accurate permeameter requiring no compensation, and of a new type of sensitive galvanometer—similar to the portable instruments used in pyrometry—so that any metallurgical and mechanical engineer or assistant will be able to make accurate determinations. This new line of magnetic testing instruments will also include a very accurate and convenient outfit for testing permanent magnets, such as are used in magnetos, etc. These instruments are being sold by Herman A. Holz, Metropolitan Bldg., New York City.

SEABOLDT LAPPED MEASURING WIRES

To provide for accurately testing the precision of thread gages and other threaded work by the familiar three-wire



Seaboldt Gaging Plugs measuring Pitch Diameter by Three-wire Method

¹Discussion on "Some Applications of Magnetic Analysis to the Study of Steel Products," Proceedings of American Society for Testing Materials, Vol. XVII, Part II, page 107

²Same proceedings, pages 110-111

method, the B. Seaboldt Corporation, 25 West Broadway, New York City, is now making sets of three steel wires which are hardened and lapped to size with a guarantee of absolute accuracy. In order to give satisfactory results, it is well known that the wires used for testing by the three-wire method must be of exactly the same size, and to meet the exceptional demand for means of checking the accuracy of thread gages which has been created through placing of large contracts for a variety of munitions of war, parts of which are required to be absolutely interchangeable, these sets of accurate measuring wires were placed upon the market. The accompanying illustration shows one simple way of using the wires, which consists of placing them on the thread gage or other part to be tested in the usual way, and using rubber bands at either end to hold the wires in place. The measuring is then done with a micrometer.

Another good way of using these wires is in connection with a Prestwich fluid gage of the type shown in Fig. 3, in the article describing thread comparators manufactured by the Coats Machine Tool Co., which appears elsewhere in the New Machinery and Tools Section of this number. The three-wire method of measurement has been adopted by the United States Government for all thread gage inspection at the Bureau of Standards and for use in all arsenals and for field inspection in various munition manufacturing plants. These sets of measuring wires, made by the B. Seaboldt Corporation, have been made for the government in sizes ranging from 0.011 to 0.144 inch in diameter, and sets have been made for the Bethlehem Steel Co. ranging in size from 0.010 to 0.150 inch in diameter. Each set consists of three wires which are guaranteed to be of the same size.

COATS THREAD COMPARATOR

In manufacturing airplane engines, motor trucks, ammunition, field guns, rifles, etc., one of the difficult problems with which manufacturers are confronted is the production of threaded parts which are interchangeable. Owing to the large scale on which the manufacture of various munitions of war is being carried on, it is necessary to produce different parts



Fig. 1. Wilhelm-Prestwich Fluid Gage Pitch Diameter Comparator made by the Coats Machine Tool Co.

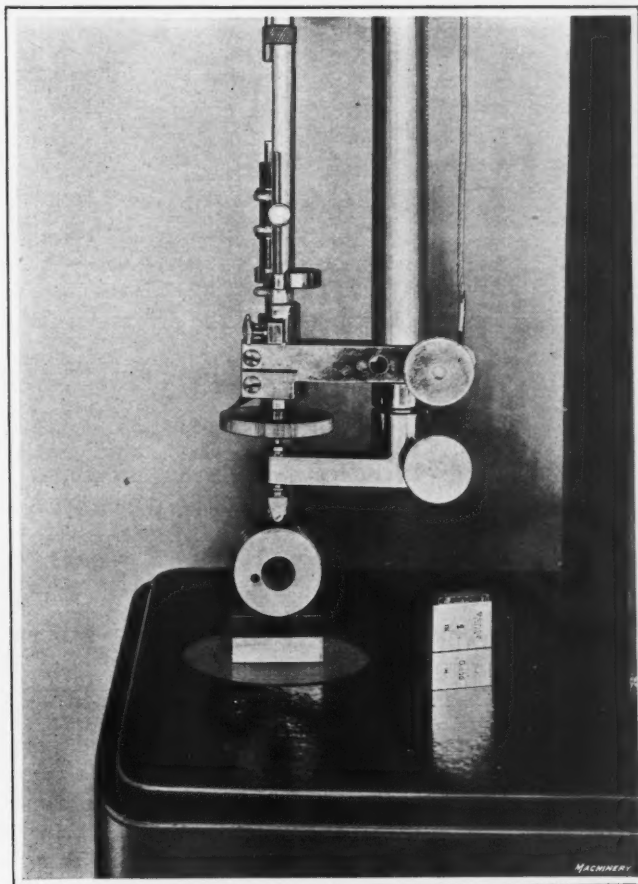


Fig. 2. Use of Swedish Gages on Pitch Diameter Comparator for establishing Size of Master Thread Gage

in widely separated plants, and under such conditions the only assurance which the manufacturer has that the parts he is turning out are interchangeable with other parts is that they measure up properly under the different gages provided for the purpose. It is usually the practice to have "master" gages which are simply used to check the accuracy of the "working" gages at specified intervals in order to see that these working gages fulfill all requirements. To provide for checking up thread gages, J. H. Wilhelm, superintendent of the gage division of the Ordnance Department of the Frankford Arsenal, designed a thread comparator to measure the pitch diameter of thread gages ranging from $\frac{1}{4}$ inch to 10 inches in diameter. It furnishes a convenient, accurate and rapid method of comparing working gages with master gages, giving the exact value of any error which may exist. This comparator may be used for establishing the size of a "master" gage through the use of Swedish gage-blocks or other standards, the accuracy of which has been properly verified by the Bureau of Standards.

The elements of the thread comparator comprise a base and an upright overhanging standard. In the base there is carried an accurately lapped steel plate which is set square with the hole through the center of the standard; a bar slides through this hole and carries the upper measuring points, which are in the form of a double roller to rest on both walls of the upper part of the thread to be measured. Underneath the thread gage to be measured there are placed two five-sided parallel blocks that are made with the same accuracy observed in the production of standard gage-blocks, the upper surfaces coming together at an angle equal to the angle of the thread to be measured. These blocks are set on the lapped steel base-plate and the gage to be measured rests upon them, the walls of the thread being in contact with the angular upper sides. This method affords an accurate and convenient comparator for measuring the pitch diameter of threaded work.

Extreme accuracy of reading is obtained by the use of a Prestwich fluid gage on this apparatus. The upper thread measuring contact or roller is carried on the lower end of a vertically slidable spindle, while the upper end of this spindle rests against the bottom of the diaphragm of the Prestwich

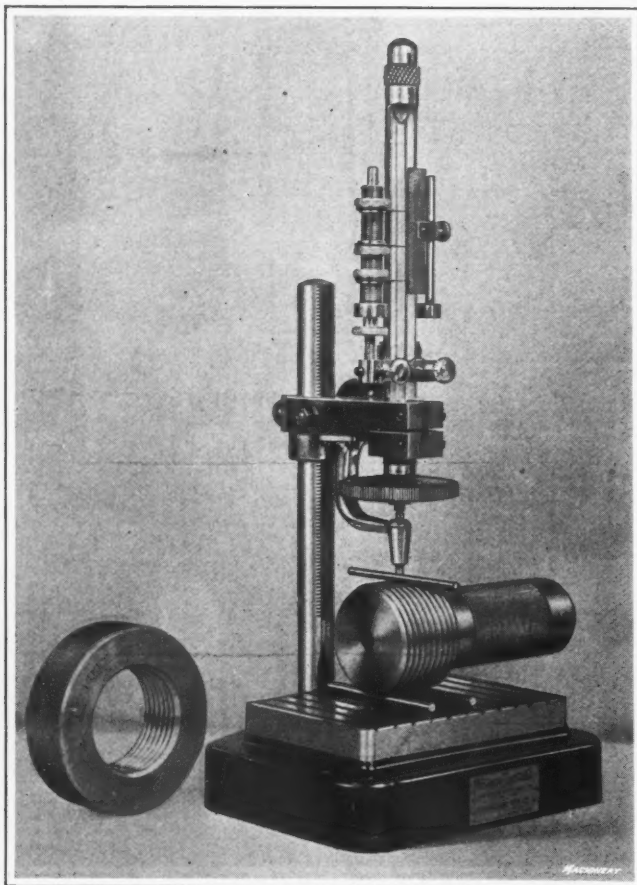


Fig. 3. Simple Type of Thread Comparator built by Coats Machine Tool Co.

gage. With this arrangement the slightest movement of the upper measuring contact gives a reading on the column of the Prestwich gage, while the thread gage being measured rests on the lower angular parallels and passes under the upper measuring contacts. When a second thread gage is passed through the machine, it will give the same reading on the Prestwich gage if it is of the same size, while if it is larger, it will cause the column to rise proportionately higher, and if it is smaller, the column will not rise as high as the position formerly reached while measuring the preceding thread gage. As a result, the difference of readings may be taken from the gage with great accuracy, as the scale on the gage is graduated to 0.0001 inch.

In order to establish the size of a thread gage with this comparator in conjunction with standard gage-blocks, the required size is first built up with the blocks and one of the angular five-sided blocks is then placed at the top of them. Then the arm carrying the upper thread measuring contact is vertically adjusted so that the contact fits over the angular sides of the block and the Prestwich gage column is at a "mean specific height." In this way the comparator may be set for any size absolutely without recourse to any other measuring machine. The master gage and the amount that a gage is above or below the required pitch diameter may be read direct from the scale on the instrument. The Prestwich fluid gage is manufactured under license for the United States and Canada by the Coats Machine Tool Co., Inc., 30 Church St., New York City. The results obtained with this thread comparator are, of course, dependent upon the use of the Prestwich gage, and the comparator has recently been added to the line of specialties made by this company.

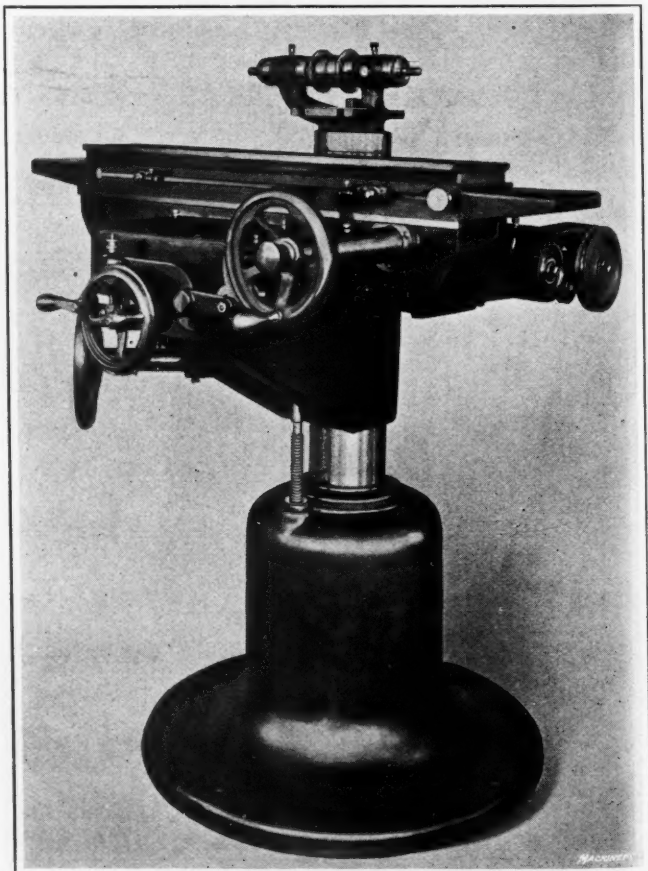
Figs. 1 and 2 show methods of setting up the thread comparator with Swedish gage-blocks, and how the comparator is used for measuring a master thread gage. It has already been explained that this apparatus was especially built to meet the requirements of the Ordnance Department of the Frankford Arsenal. It is provided with fourteen rollers of different pitches, and the equipment is of a character which makes the machine quite expensive. To meet the requirements of those shops that do not have enough gage testing to do to warrant investment in a machine of this type, the Coats Machine Tool Co. is building a simpler type of thread comparator,

which is shown in Fig. 3. It will be seen that this operates on the familiar three-wire principle, and the possibility of using the Prestwich gage in connection with this method enables the accuracy of thread gages and other threaded work to be rapidly and accurately determined. Complete information concerning the application of the three-wire method of measuring threaded work is given on pages 1031 and 1032 of MACHINERY'S HANDBOOK.

WOODS TOOL AND CUTTER GRINDER

In the accompanying illustration is shown a No. 2½ universal tool and cutter grinder which is a recent product of the Woods Engineering Co., Alliance, Ohio. This machine is designed to meet the requirements of tool-room grinding, and it will be seen that it is of the swivel head type with the work-table located directly under the countershaft at all times. All parts of the mechanism are readily accessible for cleaning, which is an important feature in the design of a grinding machine. As its name implies, the machine is strictly "universal" and will grind any cutter, reamer or other work which comes within its range, and do the work accurately and rapidly. Changes from one grinding operation to another are easily made, and provision for making all adjustments are worked out in such a way that the time involved in making changes is not excessive. An automatic longitudinal feed is a regular feature of this machine, but automatic cross-feed can also be furnished to special order. Twelve changes of table travel are obtained through change-gears and cover a range of from 24 to 143 inches per minute.

Provision is made for swiveling the head through 180 degrees and for setting it at any angle with the table by loosening a 5/8-inch clamping nut and then making the necessary setting through the use of a graduated dial at the top of the column. Dust guards are provided for the table slides and adjustable gibs provide means of compensating for any wear which may develop in these slides. The gibs extend the full length of the table and have a bearing for the full length of the saddle guide. The bearing surface of the sliding table has one vee and one flat way with ample bearing surface to maintain accurate alignment. The top table swivels on a central pivot with binding bolts at each end, so that the table may be



Woods No. 2½ Universal Tool and Cutter Grinder with Automatic Longitudinal and Cross Feed

set for grinding tapered work held between centers, or work that is clamped to the table. Graduations at the ends of the table read to 1/16 inch taper per foot. Adjustable stops limit the table travel when grinding up to a shoulder, or for similar operations.

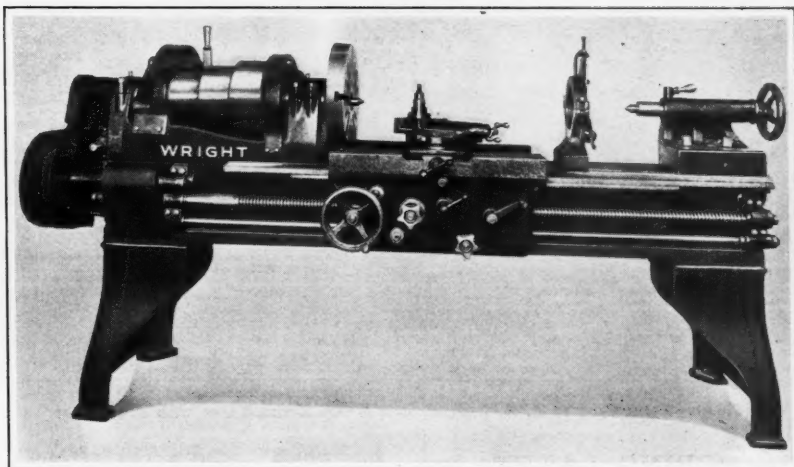
For grinding operations that require the top table to be held at a greater angle than is possible with the screw adjustment, two dogs are provided for securely clamping the two tables. The knee is of the extended and box section type and slides on a V-key that is adjustable for wear. Both elevating and cross travel screws are provided with micrometer dials. The saddle slides on the knee on one vee and one flat way, and these bearing surfaces are never exposed for any position of the table. An internal attachment for this machine has two speeds and is so constructed that the spindle has a bearing next to the emery wheel, which eliminates vibration due to a long overhang. The universal vise has three swivels, which allow it to be set in any position. The countershaft is self-contained and provides three changes of speed for the work-spindle and two changes of speed for the grinding wheel.

The principal dimensions of this machine are as follows: longitudinal travel, 22 inches; cross travel, 7½ inches; vertical travel, 10 inches; maximum distance between centers, 28 inches; swing, 9 inches; number of table speed changes, 12; dimensions of vise jaws, 1¼ inch high by 5¼ inches wide; opening of vise, 2¾ inches; and net weight of machine, approximately 1275 pounds.

WRIGHT ENGINE LATHE

David A. Wright, 568 W. Washington Blvd., Chicago, Ill., is now manufacturing an 18-inch heavy-duty engine lathe, adapted for use in the manufacture of shells, artillery hubs and other heavy-duty work of a similar nature. To stand up under this service, the machine is heavily constructed with bearings of liberal size, and with a lead-screw 2 inches in diameter. In general, the machines are capable of obtaining the maximum production from high-speed steel tools. This lathe is regularly equipped with a three-step cone pulley and double back-gears and an improved locking device, by means of which the cone pulley and spur gear can be instantly connected or disconnected, without requiring the use of a wrench. This permits the back-gears to be easily thrown in or out. Removable guards are furnished over all gears. The spindle is machined from a steel forging and is accurately ground with a hole through its entire length. The spindle bearings are lined with phosphor-bronze and equipped with oil pockets and chain oilers. Anti-friction thrust bearings are provided with a nut for adjusting the thrust washer, which is made of steel, hardened and ground.

In working out the design of the tailstock, provision has been made for setting the compound rest at right angles to the cross-slide; and the tailstock spindle is made of steel, accurately ground to size. An adjusting screw provides for setting over the tailstock for the performance of



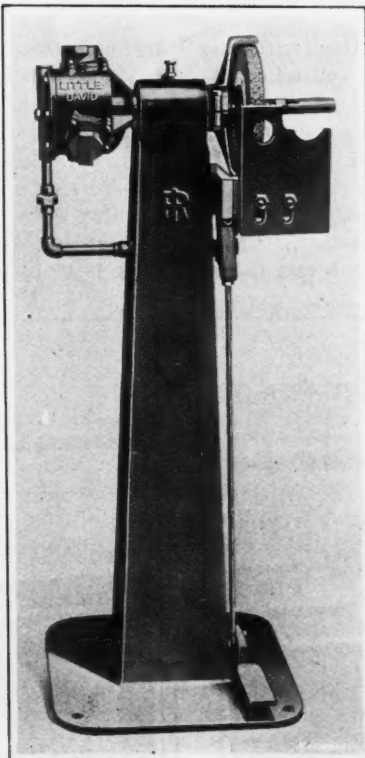
Heavy-duty Type H 18-inch Engine Lathe built by David A. Wright

is located conveniently for the operator. The compound rest is fitted with taper gibs which require only one screw for their adjustment; and the handle of the compound rest is removable, enabling it to be taken off when not in use, so that it does not interfere with manipulation of the cross-feed handle. Both the longitudinal and cross-feeds are reversible from the apron, and the longitudinal feed is so arranged that it is impossible for the lead-screw and feed-rod to be engaged at the same time. The feed reverse is controlled by a lever placed near the bottom of the apron, which is used for the turning feed only and not for screw cutting; reversal for screw cutting is obtained by shifting a lever located at the end of the headstock. A range of feeds and provision for cutting screw pitches are provided, which are sufficient to take care of all of those classes of work that are handled on a machine of this type.

The principal dimensions of this machine are as follows: swing over bed, 19½ inches; swing over carriage, 11 inches; capacity between centers, 4 feet; length of carriage bearing on ways, 30 inches; ratio of back-gears, 12 to 1; dimensions of front spindle bearing, 3½ by 6 inches; dimensions of rear spindle bearing, 2½ by 4½ inches; diameter of hole through spindle, 1⅝ inch; diameter of spindle nose, 3 inches; capacity for thread cutting, 2 to 32 threads per inch; width of driving belt, 5 inches; size of tools, ¾ by 1½ inch; capacity of steady-rest, up to 6 inches; and weight of machine with 8-foot bed, 3600 pounds. Regular equipment furnished with the machine includes a compound rest, double-friction countershaft, large faceplate, steadyrest, change-gears, and wrenches for making all adjustments that may be necessary.

INGERSOLL-RAND AIR-DRIVEN PEDESTAL GRINDER

For general service where a stationary pneumatic grinder is preferred to a portable tool, the Ingersoll-Rand Co., 11 Broadway, New York City, has designed and is placing on the market the machine illustrated herewith, which is designated as No. 8 "Little David" grinder. The three-cylinder motor with its continuous power impulse, the rotary valve integral with the crankshaft, and the triple ball-bearing spindle are of similar design to the Ingersoll-Rand No. 7 "Little David" grinder. The machine is rated to operate at 3400 revolutions per minute with compressed air at 80 pounds per square inch pressure. Control is effected by means of a convenient foot-lever. The grinding wheel usually employed is 8 inches in diameter and 1 inch face width.



"Little David" Air-driven Pedestal Grinder built by Ingersoll-Rand Co.

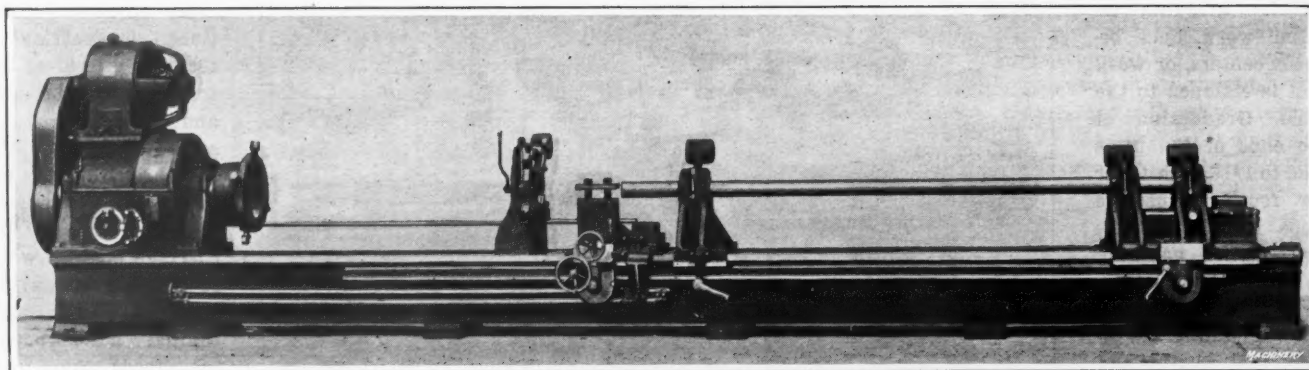


Fig. 1. Front View of R. K. LeBlond 38-inch Gun Boring Lathe with 32-foot Bed

LE BLOND GUN BORING LATHE

To meet the requirements of rough-boring tubes and jackets for guns up to 6 inches in diameter from solid forgings, and also to provide for finish-boring the rough-bored forgings, the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has placed on the market a 38-inch gun boring lathe which is illustrated and described herewith. When provided with a 32-foot bed, this machine has a capacity for boring holes 8 feet in length, and an addition of two feet to the length of bed must be made for each additional foot of length of the work to be bored.

top which forms a channel for carrying lubricant to the reservoir, no separate oil-pan being required.

This lathe is provided with a headstock of the all-g geared type, with two mechanical changes of speed obtained through sliding gears operated by a lever at the front of the headstock. The main driving gear on the spindle is pressed on and keyed to the spindle, this gear being 34 inches in diameter by 7 1/2 inches face width, and 2 1/2 diametral pitch. Provision is made for bolting the headstock to the bed by means of six 1 1/4-inch bolts and a flange 12 inches in diameter by 1 3/4 inch thick at the front end of the spindle is provided with four 1-inch bolts to receive the

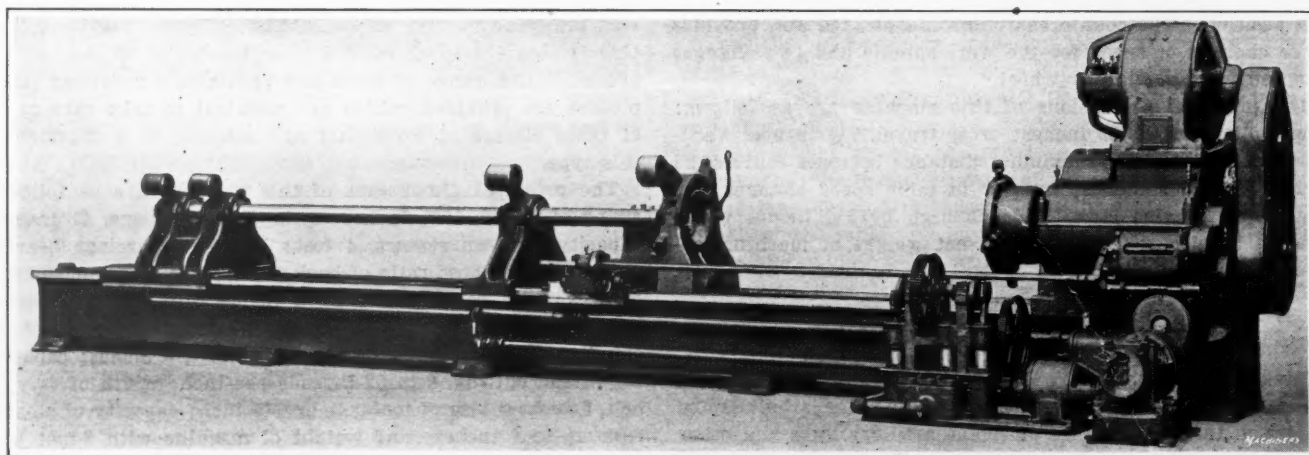


Fig. 2. Opposite Side of LeBlond Gun Boring Lathe, showing Pump and Power Traversing Mechanism

On this machine the bed is of box section with the center portion cast to form a reservoir for collecting the cutting lubricant. Flat shears are provided on the bed and the machine is equipped with a boring tailstock, a steadyrest and a support for the boring-bar, all of which are square-gibbed to the bed. Beds up to and including 32 feet in length are made in one piece, while beds above this length are made in sections and bolted together. Cross-ribs are provided in the bed, with an arched web cast in the

driving chuck. Power for driving the lathe is furnished by a 25-horsepower, three-to-one, variable-speed motor, with a range of from 500 to 1500 R.P.M.; this motor is mounted at the end of the lathe and drives through spur gears and a pinion. Spindle speeds are available over a range from 5 to 60 revolutions per minute, and the motor controller is operated through a lever located on the carriage.

Mention has been made of the fact that the boring tailstock is gibbed to the bed. This tailstock is furnished with

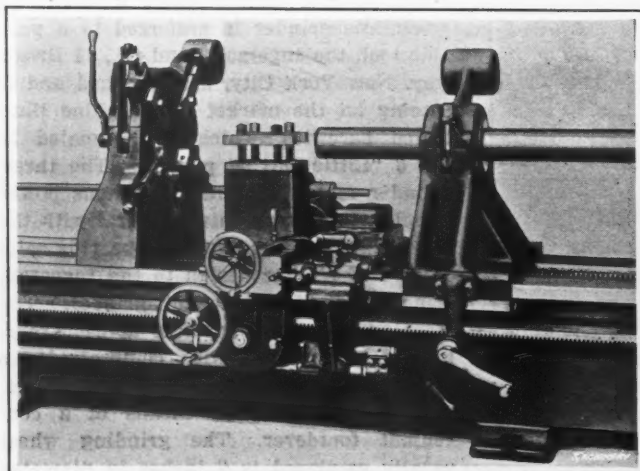


Fig. 3. Carriage, Boring Tailstock and Steadyrest in Position

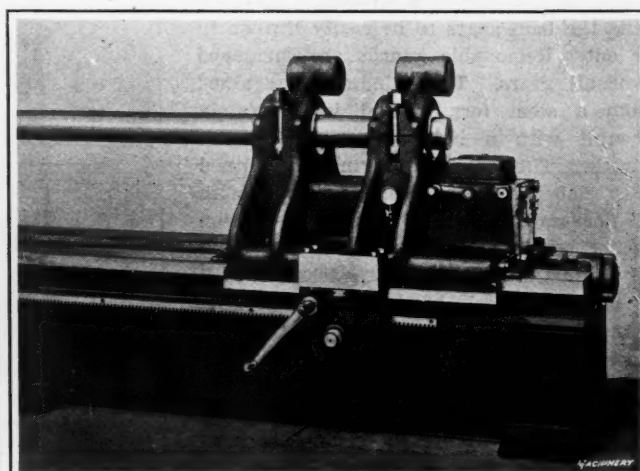


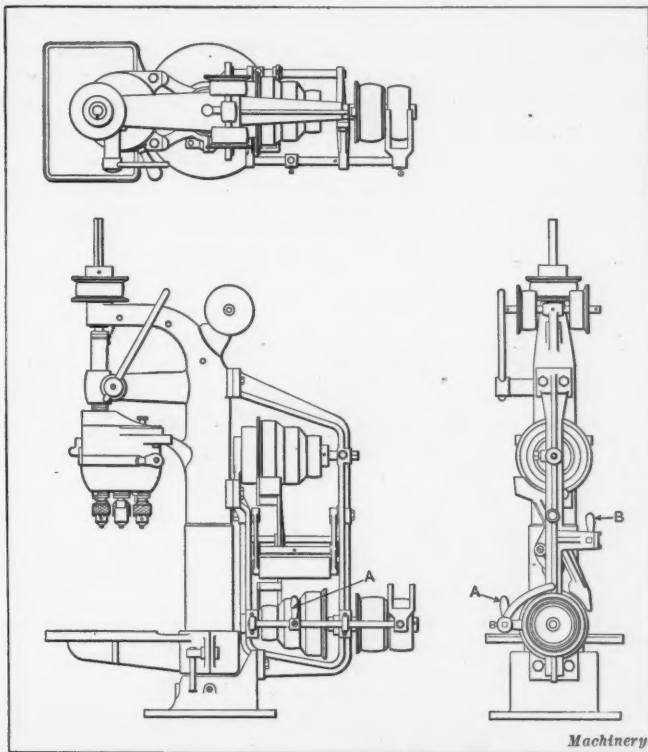
Fig. 4. Close View of Boring Tailstock of LeBlond Lathe

double bar supports which have counterbalanced hinged caps. These bar supports are bored 5 to 7 1/2 inches in diameter; and the tailstock is provided with rapid power traverse and a rack and pinion for hand adjustment. Feed to the boring tailstock is obtained through a screw 3 1/2 inches in diameter by 3/4 inch pitch, which is located and supported in bearings in the center of the lathe bed. The screw engages bronze half-nuts, made in separate pieces and easily renewable. The drive to the screw is through a worm and worm-wheel provided with ball thrust bearings. Feed changes are obtained by means of change-gears and cover a range from 0.004 to 0.064 inch per revolution of the spindle. The boring-bar support is square-gibbed and clamped to the shears, and provided with a counterbalanced hinged cap; it is bored 8 1/2 inches in diameter and bushed down to suit the boring-bar. This support has a bearing of 16 inches on the shears and the bearing for the boring-bar is 8 3/4 inches.

The carriage is furnished with automatic feed, quick-power traverse and a rack and pinion for hand adjustment, the same as the boring tailstock. It is provided with a plain tool-slide with cross adjustment by hand only. The length of the carriage on the shears is 24 inches and its width is 38 1/2 inches, provision being made for holding a tool 1 by 2 inches in size. Two steadyrests are furnished with the machine, which have a capacity from 1 to 18 inches and 1 to 24 inches in diameter, respectively; they are provided with five jaws and a removable cap, the jaws being faced with bronze. Both the boring tailstock and carriage have rapid traverse in either direction, which is obtained through a central screw in the bed and an independent motor mounted at the rear of the lathe. This motor develops 5 horsepower and runs at 1150 R.P.M.; it is controlled by a special E. C. & M. controller and solenoid brake operated by a lever on the carriage, which also starts and stops the feed.

A triplex single-acting pump of 4 by 4 inches capacity is direct-connected to a 3-horsepower motor for forcing lubricant onto the cutting tool, this pump having a capacity for delivering 32 gallons of lubricant at a pressure of from 40

been developed and placed on the market at that time by J. N. Landau, of New York City. Recently, the Landau Machine & Drill Press Co. has been incorporated, and in its shop at 368-370 Broome St., the drilling and tapping machine shown in the accompanying illustration is being built. Comparing it with the machine previously described, it will be seen that the two designs are essentially the same, except that the



Landau Multiple Drilling and Tapping Machine with Cone Pulley Drive

present machine is furnished with means for quickly obtaining any of three speed changes, speeds of 650, 1150 and 1800 revolutions per minute being available. It will be seen that at the right-hand side of the machine there is a sliding bar, at the rear end of which is carried the belt shifter which moves the belt from the tight to the loose pulley and *vice versa*, this bar being manipulated by handle A.

Similarly, at the left-hand side of the machine there is a belt shifter manipulated by handle B, which throws the belt to one of the three steps on the cone pulleys. A long idler pulley of the same width as the three steps on the cone pulleys, provides for maintaining a uniform belt tension. This machine has a capacity for drilling holes up to 1/4 inch in diameter; and for the performance of tapping operations in iron or steel the capacity is 3/16 inch, while 1/4-inch holes may be tapped in brass. The tapping attachment is driven from the main spindle when the latter is running at 1150 R.P.M., and gives a speed of 140 R.P.M. for the tapping spindle. Hand feed is employed on this machine.

LANGELIER TURNBUCKLE DRILLING MACHINE

The machine shown in Figs. 1 and 2 was designed by the Langelier Mfg. Co., Arlington, Cranston, R. I., especially for drilling the central tap hole in tobin bronze airplane turnbuckles, ranging in length from 2 to 4 inches. The drilling is done simultaneously from both ends, thereby reducing the drilling time to at least 50 per cent of that required by a single-spindle drilling machine. An ordinary, inexpert operator, will easily average sixty buckles drilled per hour on 4-inch turnbuckles, and for shorter lengths he can do considerably more. The two drilling spindles in this machine advance and withdraw in unison, when the operator moves a single pilot connected by gearing highly compounded for easy operation of both spindle sleeves. The construction of the machine consists of two heads fitted with these sleeves geared to a

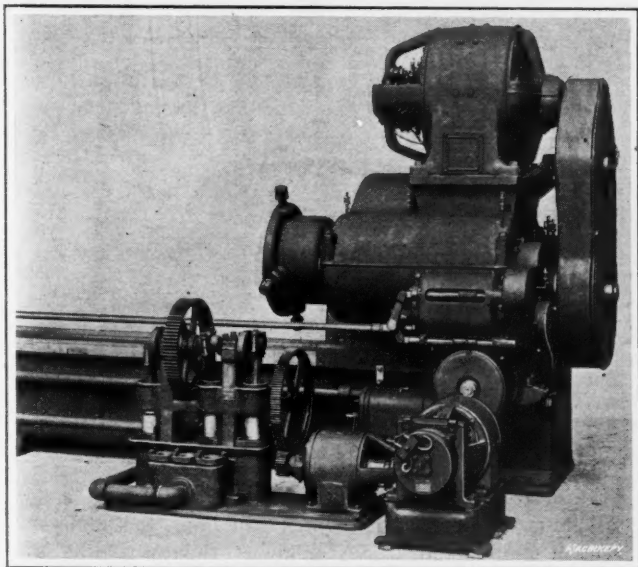


Fig. 5. Close Rear View of Head End of Lathe, showing Motor Mounting

to 50 pounds per square inch when running at 50 revolutions per minute. A boring-bar is not furnished with the machine, but the boring tailstock is arranged with piping from the pump to deliver lubricant to the boring-bar. The weight of this machine including the motors, pump, etc., is approximately 36,000 pounds, and the weight per extra foot of lathe bed is 450 pounds.

LANDAU MULTIPLE DRILLING AND TAPPING MACHINE

In the July, 1916, number of MACHINERY there was published an illustrated description of a multiple-spindle drilling and tapping machine of the turret head type, which had just

vertical pinion that meshes with interconnected racks inside of the bed. The feed is operated by a three-armed handwheel that is connected by gears to the feed sleeve; and the drilling spindles run on ball bearings that are mounted inside of the feed sleeves. They are driven by flanged pulleys mounted on their outer ends and are belted to wide drum pulleys on the overhead countershaft. An adjustable drilling stop is provided on the right-hand head.

To avoid the drills coming together at the center, the left-hand head is provided with a feed release mechanism that can be adjusted to operate just before the drill ends meet. The spindle is returned by the pull of a long spring, seen at the left-hand end of the machine. Both spindles have adjusting collets with sockets to take No. 2 Jacobs chucks with taper shanks. The size of drills used for the 4-inch turnbuckles was No. 12 drills, 6 inches long; they were made of

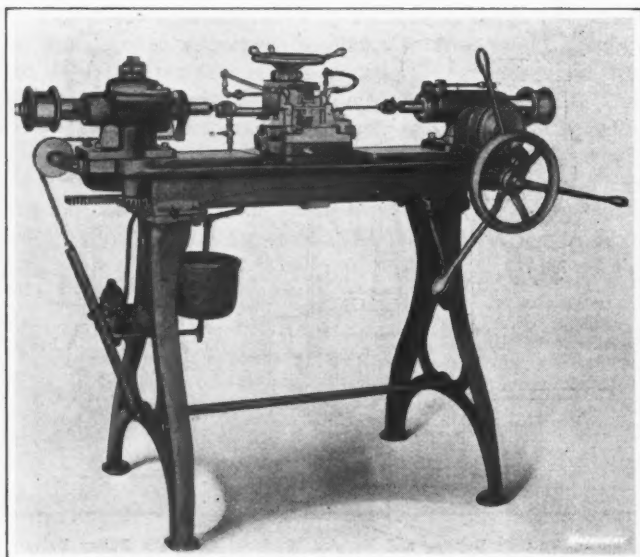


Fig. 1. Langelier Two-spindle Horizontal Turnbuckle Drilling Machine

high-speed steel and run at a speed of 3000 revolutions per minute. The expense and difficulty of getting special length drills, that would be required when drilling from one end are avoided, as the drills used in this machine are standard stock lengths. The turnbuckles are located and held in the drilling position by a specially designed vise, which is located midway between the drilling heads, and this vise is controlled by one-half turn of a handwheel. The turnbuckles are first centralized both axially and lengthwise, by two opposed 60-degree cupped bushings mounted in T-slides that are operated by a double path spiral cam. This cam is geared to the handwheel shaft. After the turnbuckle is centralized, a plier type of vise jaw that is operated by a circular double wedge cam, mounted on a handwheel shaft, grips the central portion of the turnbuckle and holds it without affecting its alignment while it is being drilled. The vise can be adjusted to take turnbuckles from 2 to 4 inches in length. This machine is provided with an automatic oil feed that delivers oil

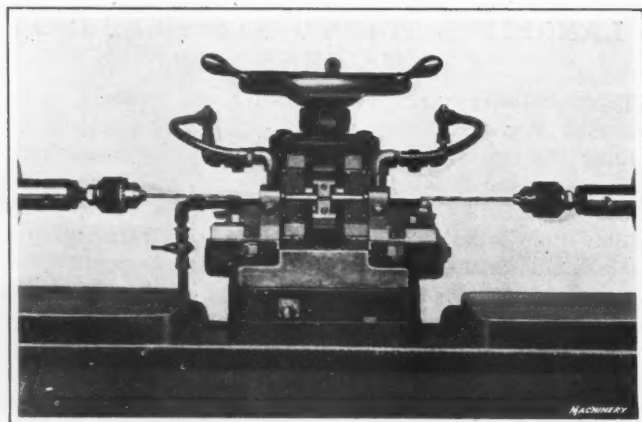


Fig. 2. Close View of Drills and Work on Machine shown in Fig. 1

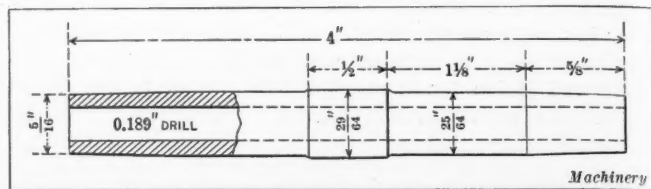
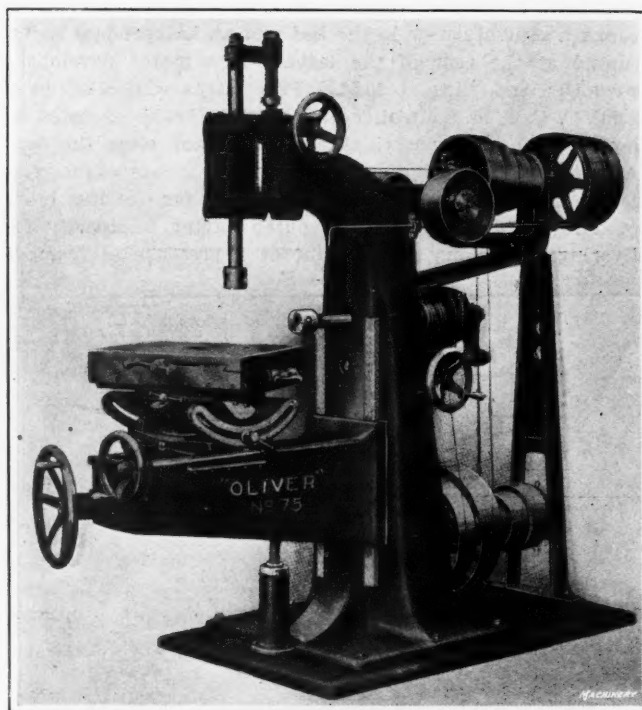


Fig. 3. Tobin Bronze Airplane Turnbuckle drilled in Machine shown in Figs. 1 and 2

to the drills only when they are cutting. The oil is fed directly into the locating bushings by means of metallic flexible tubes; and the oil-pump is belted direct to the countershaft. The floor space occupied by this deep-hole drilling machine is 5 feet, 9 inches by 2 feet, 2 1/2 inches and the machine stands 49 inches high.

OLIVER WOOD MILLING MACHINE

In the accompanying illustration there is shown a No. 75 wood milling machine, which is a recent product of the Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. In general respects the design of this machine follows that of an Oliver wood milling machine which has been on the market for some time, but the design has been improved in certain important details. Among these changes the most important is the provision of a new form of table which,

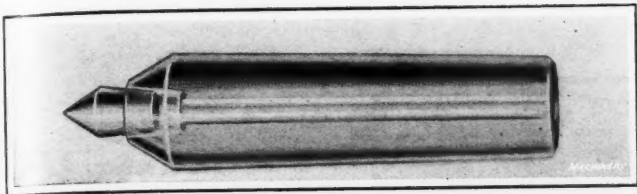


No. 75 Wood Milling Machine built by Oliver Machinery Co.

like the original table, may be tilted and rotated in a horizontal plane, in addition to which the improved table may be rotated in a plane at any angle to the horizontal, thus making the machine entirely universal. Compound cross-slides are located above the double swivel and tilting mechanism so that these slides will operate in any position. There was only one slide on the old table. In addition to the change in table design, the column of the machine has been broadened and made of heavier construction, while the size of the base has also been increased, the result of these changes being to render the machine practically free from vibration.

HOOVER INSERTED-POINT CENTERS

In the accompanying illustration there is shown what is known as an "inserted-point" lathe center, which is a recent product of the Hoover Mfg. Co., Anderson, Ind. It will be seen that this consists of a holder and center point,

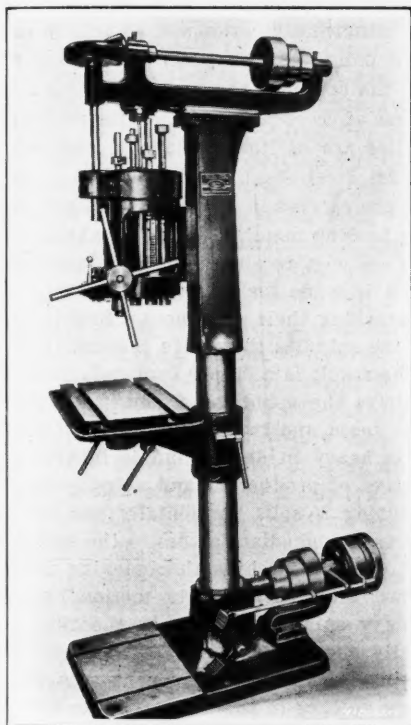


Hoover Inserted-point Lathe Centers

and the use of this form of lathe center enables new points to be inserted without the necessity of grinding centers back to the required form. In this way the production from each machine is increased and a saving of steel is also effected.

TURNER TURRET TYPE DRILLING MACHINE

In the accompanying illustration there is shown a Model B turret type drilling machine, which is a recent product of the Turner Machine Co., Danbury, Conn. It will be seen that this machine is built with a round column, and either a round or square table is provided. The table is swung on a universal knee which is attached to the column, so that the table may be tilted to any desired angle required for handling the work. Graduations on the universal joint enable the operator



Turner Model B Turret Type Drilling Machine

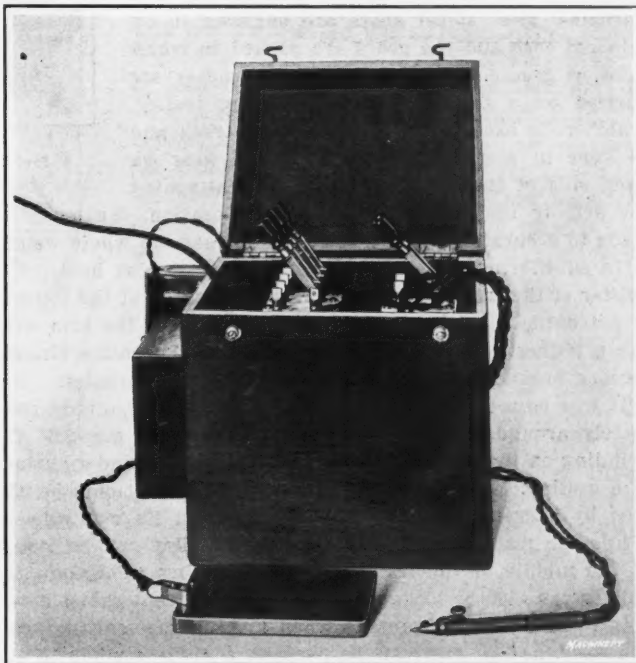
to set the table readily to any angle desired; the table can also be removed, giving the machine a very wide range. When a square table is furnished on the machine it is 16 1/2 by 24 inches in size and fitted with an oil-pan. The round table furnished on the machine is made in two sizes, 18 or 20 inches in diameter. Mention has already been made of the fact that the table may be removed from the machine to enable work to be set up on the floor base, which is of exceptionally large size and planed true with the column to assure accuracy of work machined while held on the base. Four spindles are provided on this machine, only one of which is in operation at a time. After each operation of the sequence has been completed, the next spindle is indexed to the operating position and this spindle then becomes operative while the other three spindles are idle. An oil tank, pump and piping are furnished when required in connection with those drilling operations for which the use of coolant is necessary.

ROBINSON ELECTRICAL ENGRAVING MACHINE

An improved machine for electrically engraving hardened steel tools, etc., with any kind of mark or name has just been placed on the market by the Production Equipment Co., 118 E. 28th St., New York City. The machine is made for this company exclusively by the R. I. Electrical Tool Co., Providence, R. I. As will be understood from its name, the Robinson electrical engraving machine does not require the use of acid, as in the ordinary etching process, thus eliminating the trouble caused by acid spots, to say nothing of the time

taken in applying the wax and acid process. With this engraving machine, the tool or piece of work to be marked is simply placed on the plate shown in the forepart of the illustration, and the etching pencil is used in the same way as an ordinary pencil, for etching in the steel whatever mark or lettering is required. A special resistance block with adjusting switches is supplied for regulating the depth of the etching and to accommodate various thicknesses of steel, down to even ribbon steel.

The Robinson electrical engraving machine is exceedingly simple to use. Lettering of any kind can be marked on metals

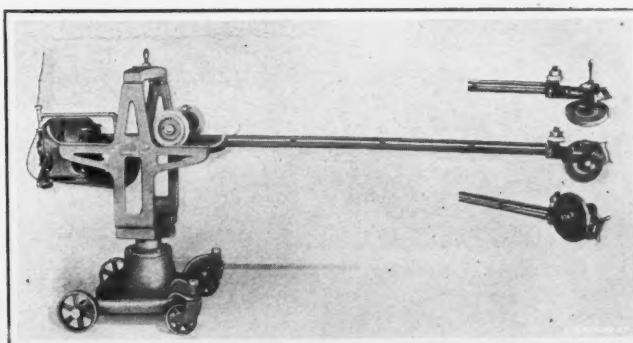


Robinson Electrical Engraving Machine sold by Production Equipment Co.

with no more effort or time than is required to write with an ordinary pen or pencil. Electrical connection is made from an ordinary electric light socket, and there is nothing to get out of order. The cost of operation is negligible. The standard equipment is suitable for use on alternating-current circuits, but a special converter can be supplied for direct-current circuits. This machine has been brought out principally for use in marking tools, gages, etc., such as are used in every machine shop, not only in the case of new tools, but also those used in any tool-room, thereby reducing to a minimum the liability of their being stolen. The chief point of advantage of this method of marking is that a special patented feature prevents sparking each time the pencil is applied to or removed from the piece of work to be marked.

MUMMERT-DIXON RADIAL GRINDER

The 8-inch portable radial grinding machine which forms the subject of the following description is a recent product of the Mummert-Dixon Co., Hanover, Pa. It will be seen that this machine is motor-driven without the use of belts, and it is equipped with ball bearings, so that all movements are easily made. This is said to be an exceptionally convenient



Mummert-Dixon 8-inch Portable Radial Grinding Machine

machine for the performance of grinding operations in inaccessible positions, and it is well adapted for general classes of light grinding and buffing. The flexibility of the machine adapts it for handling a wide range of work.

To adapt the machine for portable service, it is made self-contained, with the grinding wheel driven by an electric motor mounted at the rear end of the tubular arm. This motor is coupled direct to a shaft which runs through the tubular arm to a set of hardened spiral gears in the head that drive the grinding-wheel arbor. The hardened steel spiral gears are enclosed in an oil-tight case and the gears are packed in transmission grease. The head, arm and motor are carried on a two-wheeled ball bearing trolley, which rolls back and forth on a steel track and is kept in alignment by a rack and gear on each side of the carrying frame. By attaching the arm to the trolley at the proper location, the motor is made to accurately balance the head so that the whole weight is in equilibrium when the workman releases his hold. The bolster of the trolley-carrying frame is mounted at the top end of a trunnion which turns in the base, so that the arm with the grinding head can be turned through the entire circumference around the base, making a full radial grinder.

It will be seen that the head can be twisted or turned completely around, making it possible to use this machine for grinding on the top, along either side, or on the under surface of a casting. The machine is portable, so that it may be carried by a crane or rolled over the floor on its own wheels. While the machine is being moved the trolley can be locked at the middle of the frame, and by dropping a lock-pin, the bolster can also be locked to the base to prevent radial movement. This is an advantage when moving the machine over the floor, as the arm can be used as a guide similar to the tongue on a wagon. All hand movements on this machine are easily made, and provision for the operator's safety is assured by means of guards covering all running mechanism except half of the grinding wheel. The electric switch is conveniently located within reach of the operator and the electric wires are protected by a steel conduit running along the top of the arm. The grinding wheel arbor is driven at a speed of 2800 R.P.M. and the electric motor develops one horsepower. A single-phase or other type of motor suitable for connection to electric lighting circuits is most convenient for use on this machine when it is to be moved about from one place to another. The length of the arm from the trolley to the head is 7 feet and the maximum travel of the trolley is 30 inches, while the vertical movement of the head is from the floor to as great a height as a man can reach. The over-all height of the machine is 4 feet, 6 inches; the maximum length, 9 feet; the base area, 30 by 30 inches; and the net shipping weight, 700 pounds.

The flexibility of this machine makes it well suited for handling a wide range of grinding operations, in addition to those classes of work for which a radial grinding machine is especially adapted.

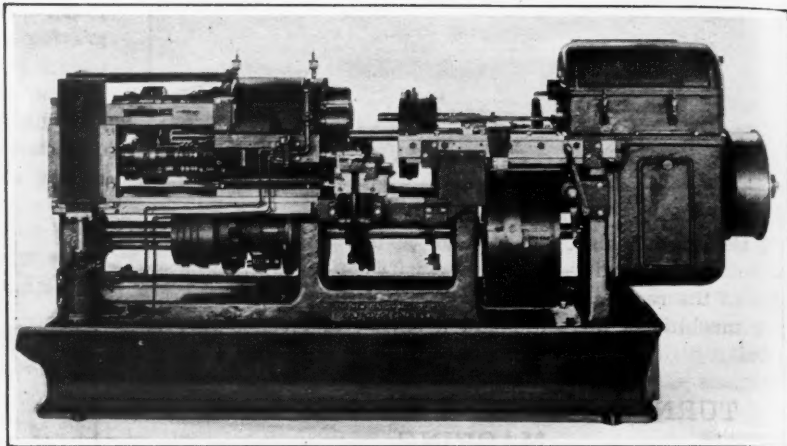


Fig. 1. Front View of New Britain Multiple-spindle Automatic Chucking Machine

NEW BRITAIN AUTOMATIC CHUCKING AND BAR MACHINES

The New Britain Machine Co., New Britain, Conn., is now building an automatic multiple-spindle chucking machine of the work-revolving type which is shown in Figs. 1 and 2. This machine, although designed to handle much the same variety of work as the regular single-head automatic chucking machine, exhibits two main points of difference, i. e., the work is held and revolved by the spindles, the tools being fixed in the tool-slides; and the use of cross-slide tools is thus rendered possible. The six spindles are of liberal diameter, hammer-forged from chrome-nickel steel, heat-treated, hardened and ground. These spindles are carried in bearings of ample proportions, made of bronze bearing metal, ground straight inside and tapered outside. In order to retain the original accuracy of the machine, provision is made for taking up the wear in the bearings without disturbing their alignment. Ball thrust collars are provided on the spindles to receive the end thrust due to tool pressure. The result is a 30 per cent reduction in the power required to drive the spindles. Change-gears provide five rates of spindle speed and twelve variations of feed.

The spindle cylinder is heavy in design and is indexed at constant speed, irrespective of production and spindle speed. The spindle cylinder housing is split horizontally and has a loose cover, which permits of immediate access to the spindle-bearing adjusting nuts. On this machine the indexing mechanism, which is patterned after the "Geneva motion," gradually accelerates the heavy spindle cylinder at the time of indexing and as gradually checks its motion without shock. Final accuracy in indexing is controlled by means of a wide rectangular latch entering notches in the circumference of the spindle cylinder. A differential or hurry-up motion is regularly fitted to this machine and indexes the spindle cylinder and operates the tool-slide at high speed when the tools have finished cutting. Draw-in spring collets of special design are employed, which will operate satisfactorily where pieces do not show a variation exceeding 1/32 inch in diameter. If there is a greater variation than this, the parts should be sorted into lots and the spring chucks adjusted to each lot. The machine is regularly equipped with a handwheel for operating spring chucks for holding the work, and, if desired, an air-chucking attachment may be provided, with an air cylinder of large size to insure successful operation on low air pressure. This device makes chucking a simpler, easier and quicker operation, resulting in accelerating production where the operations are short.

To insure protection of the operator, the spindle is automatically disconnected from the drive while loading and unloading. A threading attachment may be installed in the fourth tool-slide position. For work which is to be handled from a chucking lug, and which requires no threading, the machine may be arranged to index in the opposite direction (clockwise), thus bring-

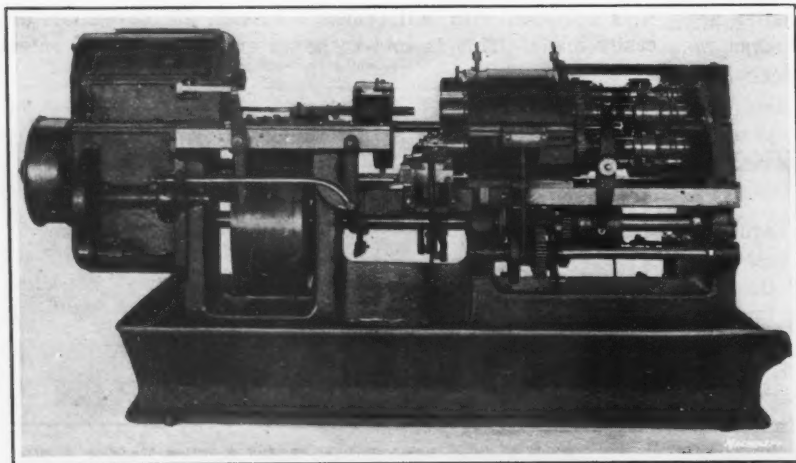


Fig. 2. Opposite Side of New Britain Automatic Chucking Machine shown in Fig. 1

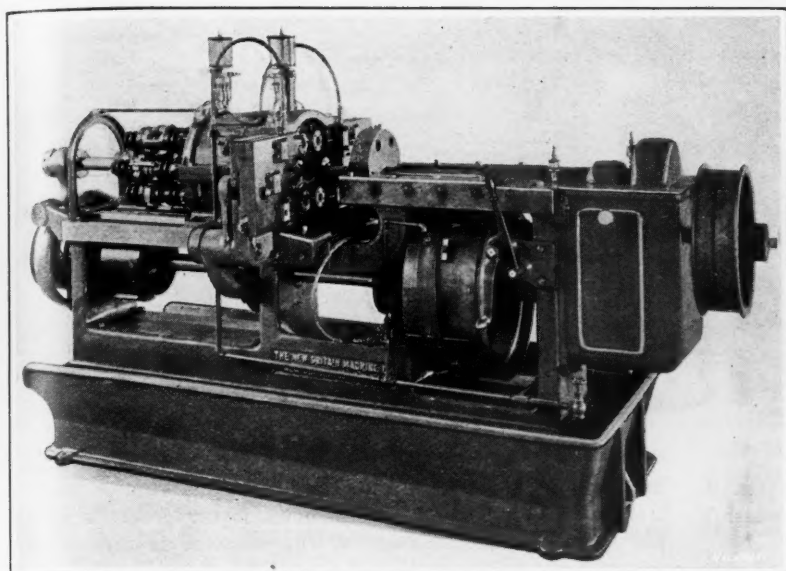


Fig. 3. Front View of New Britain Sextuple-spindle Automatic Bar Machine

ing the finished piece to its final position opposite a cross-slide, which may be fitted with a cutting-off blade. It is possible in this machine, with the work revolving, to handle second-operation work so that the first and second operations will be concentric. The tool-slide is of extremely rigid construction and so designed that the thrust of the work above and below the center line is evenly balanced, thus eliminating any tendency to bring a cramping strain upon the tools. The slide has five tool positions. The tool-slide cam is laminated similar to a leaf spring. This patented construction permits of adjustment of one cam to all lengths of work within the capacity of the machine. Drive to the camshaft is through a large internal gear on the inner circumference of the feed cam drum, and the thrust of the tool-slide against the feed cam is taken by a hardened steel roll fixed to the frame, which bears against the edge of the drum. Standard tools, drills, reamers, etc., are used, the direction of spindle rotation being right-hand.

All gearing is machine cut, largely by the generating process, which produces a quiet, smooth-running machine. Hand control levers on each side, within easy reach of the operator, enable the power feed to be instantly stopped or started. These, in connection with a hand feed crank for testing all feed movements and tool positions, are essential features of a machine of this type. In setting up, testing and adjusting tools they save breakage. The oil distributing system is designed to avoid as much exterior piping as possible. This is accomplished by conveying the oil through the under side of the tool-slide into a chamber at the center surrounding the driving shaft bushing, from which it is tapped off at the circumference through short tubes to the individual tools. The oil-pump is driven at constant speed. The base forming the chip-pan extends to the floor, thus dispensing with legs; and the broad foundation thus obtained, together with the stiff construction and ample weight of the machine, tends to prevent vibration and insure smooth, accurate work. That portion of the bed directly beneath the work has a 45-degree slant toward the back side of the machine, so that chips, as they are cut off, are carried to the side. The chip-pan is widest on this side and slopes toward the rear end, where there is an oil-well with a strainer, from which oil is distributed to the work. This construction permits the oil to drain off before the chips are removed and makes it possible to rake out the chip-pan endwise without stopping the machine or removing the splash apron. The New Britain automatic chucking machines may be equipped with either belt or motor drive.

New Britain Sextuple Automatic Bar Machine

The New Britain sextuple automatic bar machine, shown in Figs. 3 and 4, is similar in con-

struction in many respects to the six-spindle automatic screw machine. In the present machine, however, the spindle cylinder does not index, the machine being designed to feed, drill, chamfer and cut off in each position. On simple work, such as rolls, sleeves, couplings, etc., this makes possible production rates six times those obtainable on single-spindle automatics. Change-gears provide six rates of spindle speed, and a separate system of change-gears is provided for effecting changes in feed by varying the speed of the camshaft. The spindle cylinder housing is split horizontally and has a loose cover, which permits of immediate access to the spindle-bearing adjusting nuts. By withdrawing the locking pin, the cylinder may readily be revolved into any desired position. A differential or hurry-up motion is regularly fitted to this machine and operates the tool-slide at high speed when the tools have finished cutting. Standard drills are used, the rotation being right hand. In other respects this machine is the same as the chucking machine.

VICTOR ENGINE LATHE

The Victor Lathe Co., 151 Lafayette St., New York City, is now manufacturing the 9-inch Victor engine lathe which is illustrated and described herewith. This machine is built in both the bench type shown in the illustration or with legs so that the lathe may be set up on the floor; and in addition to the power-driven machine, a lathe of this type is built to be operated by foot power. These Victor lathes have been designed to meet the requirements of tool-rooms, experimental departments and manufacturing shops handling small work. The design embodies the latest improvements in lathe construction, and the usual power-driven cross- and longitudinal-feed movements are available. A reverse lever on the headstock enables both right- and left-hand threads to be cut, and the same lever provides for operating the longitudinal- and cross-feeds in either direction. The gears are all covered to meet the requirements of the various state laws concerning provisions for safety of the operators.

On this lathe the headstock is ribbed to provide the necessary rigidity, and the hollow spindle is accurately ground to size with a 5/8-inch hole extending through its entire length. The three-step cone pulley carries a 1 1/4-inch belt and the spindle bearings are bushed with phosphor-bronze. The tailstock is of the offset type, and has a long bearing on the bed; this tailstock is furnished with side adjustment for the performance of taper turning operations. The carriage and apron are securely gibbed to the bed and provided with liberal sized bearings on the ways. The design has been so worked out that only one of the two power feeds can be used at any one time, thereby avoiding danger of breaking the gears. A

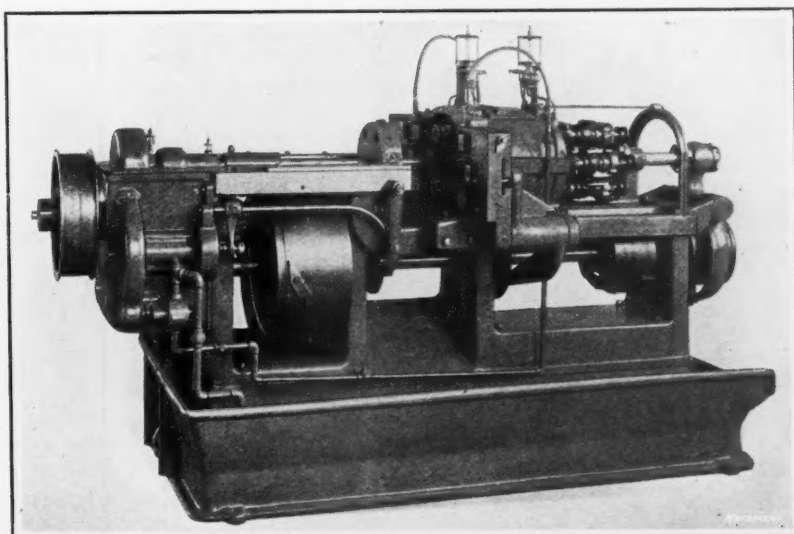


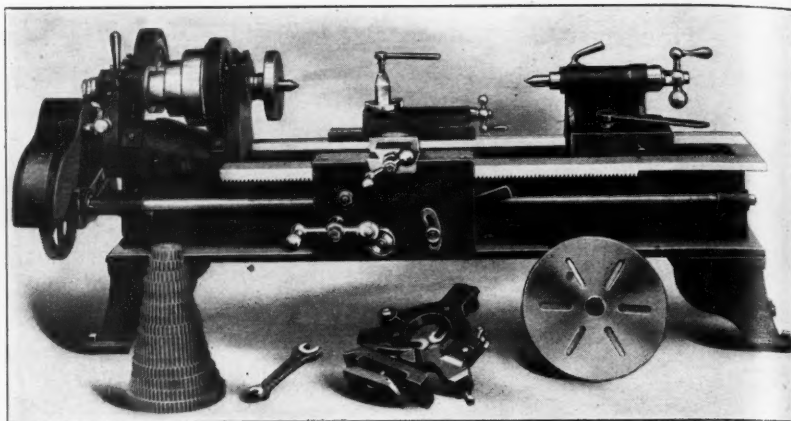
Fig. 4. Opposite Side of New Britain Automatic Bar Machine shown in Fig. 3

locking device is provided which secures the carriage in any given position when the cross-feed is being employed, and the cross-feed screw is furnished with a micrometer collar reading to 0.001 inch. The bed is reinforced at frequent intervals to provide the necessary rigidity, and the feed rack is cut from one solid piece of stock. The compound rest is securely gibbed and graduated in degrees. For thread cutting, the range is from 4 to 40 threads per inch, with the regular equipment on the machine, but metric threads and finer threads than indicated above may be cut through the use of special gears. The split nut is so constructed that it cannot be engaged when either feed is in use. The regular equipment furnished with the machine includes large and small faceplates, a steadyrest, a toolpost, a compound rest, a double friction countershaft or foot-treadle, a full set of screw cutting change-gears, and the necessary wrenches for making all adjustments.

The principal dimensions of this lathe are as follows: swing over ways, 10 inches; swing over carriage, 6 3/8 inches; diameter of hole through spindle, 5/8 inch; taper of center hole of spindle, No. 2 Morse; diameter of spindle nose, 1 3/8 inch; number of threads per inch on spindle nose, 8; size of front spindle bearing, 1 1/4 by 2 1/4 inches; size of rear spindle bearing, 1 1/16 by 2 inches; dimensions of three-step cone pulley, 2 1/4, 3 5/8 and 5 inches, by 1 1/4 inch face width; ratio of back-gears, 7 to 1; diameter of tailstock spindle, 1 inch; maximum distance between centers, 22 inches; range for thread cutting, 4 to 40 threads per inch; size of lathe tools used, 3/8 by 3/4 inch; size of pulleys on countershaft, 7 by 2 1/4 inches; speed of countershaft, 200 R.P.M.; and net weight of machine, 450 pounds.

MARTIN HYDRAULIC MARKING MACHINE

The Martin Machine Co., Greenfield, Mass., has recently placed on the market the marking machine shown in the accompanying illustrations. This is a hydraulically operated



Bench Type of Engine Lathe built by Victor Lathe Co.

machine and is intended for the rapid marking of names, trademarks and nomenclature upon metal products, shells, etc. An important feature of the machine is that it will mark evenly, irrespective of the working surface of the article to be marked, that is, the marking pressure varies with the resistance of the die in impressing the lettering. Fig. 1 shows the front view of the Martin marking machine and Fig. 2 shows the rear view. By referring to these illustrations the operation of the machine may be clearly followed.

Referring to the rear view of the machine, power is received on the driving pulley as shown and this operates a rotary pump within the column of the machine, for the purpose of operating the hydraulic system which controls the movements of the marking slide and work-table. By means of this pump the oil pressure is maintained, and this pressure operates both the vertical table that raises the work to the marking dies and also the horizontal die-holding slide. In operation, pressure upon the foot-treadle, that may be seen in Fig. 1, causes the oil pressure to raise the work-holding table to the operating point, and when this point has been reached the oil pressure also commences to act upon the slide, and then traverses the die across the work to be marked. As soon as the die has completed its travel across the work an adjustable stop

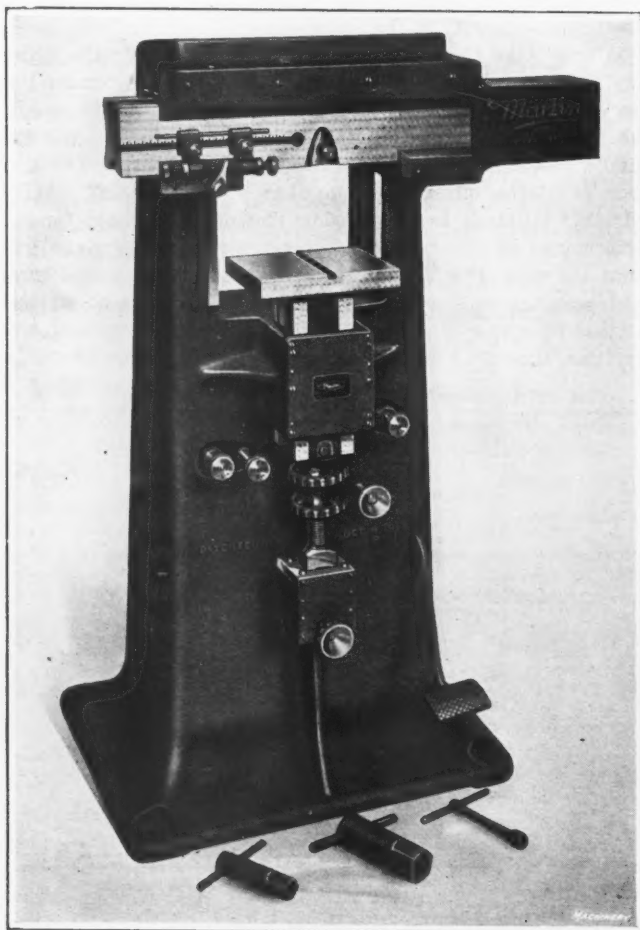


Fig. 1. Martin Hydraulic Machine for marking Shells and Other Metal Products by Impression Method



Fig. 2. Opposite Side of Martin Hydraulic Marking Machine shown in Fig. 1

on the slide trips the reverse lever, shown in Fig. 2, that operates the valve, releasing the pressure that has moved the slide forward and allowing the oil pressure to return the slide to the starting point. At the same time the oil pressure beneath the work-table is immediately released and the table drops back ready for the removal of the work.

Through the compounding system inside the column of the machine, pressure beneath the work-table is automatically increased when the action of the slide in forcing the die across the work becomes harder. Thus should the pressure required for marking suddenly change during the stroke, the result would be to automatically increase or decrease the hydraulic pressure under the work-table and supply an amount of pressure to give an even impression, irrespective of the amount of lettering on the die and the unevenness of the surface being marked. On the machine it is possible to mark either cylindrical or flat work, and by using special holding attachments irregular surfaces may be handled. In marking flat work, cylindrical or roll dies are used that turn as they are rolled across the article being marked. Conversely, in marking cylindrical work, a flat die is used in a die-holder which is inserted in the slide, and the work turns as the die is traversed across.

All adjustments provided are readily accessible for increasing or decreasing the pressure on the table, the speed of the slide, etc. The capacity of the machine is from one to ten lines of $\frac{1}{8}$ -inch letters, and the maximum length of lines is 11 inches. The length of stroke of the die-holding slide may be quickly and easily adjusted to any desired length by means of the adjustable stops shown in Fig. 1. The work-table is readily adjustable from 0 to 6 inches, according to the requirements of the work. A feature of the machine is its simplicity and practically automatic operation, requiring almost no adjustment on the part of the operator. The machine may just as effectively be operated by girls and unskilled labor. Provision is made for holding interchangeable die-holders so that the change from one class of articles to another is quickly made. For continuous marking, the foot-treadle may be depressed and caused to catch, allowing the operator to devote his entire time to inserting and removing the work. In this connection the machine may be set at any desired speed and run continuously just fast enough to allow the work to be removed and inserted between strokes. The machine requires a floor space of 24 by 30 inches and weighs 900 pounds.

RED-E BENCH LATHE TOOL-HOLDER

The Ready Tool Co., Bridgeport, Conn., has recently added to its line of Red-E tool-holders a Style 00 tool especially adapted for use on bench or watchmakers' lathes. This tool-holder is $\frac{5}{16}$ by $\frac{1}{2}$ inch in size, and it takes a $\frac{3}{16}$ -inch square high-speed steel cutter. Solid tools have generally been used on bench lathes and watchmakers' lathes, and it was to enable the users of such machines to economize in the



Red-E Bench Lathe Tool-holder made by the Ready Tool Co.

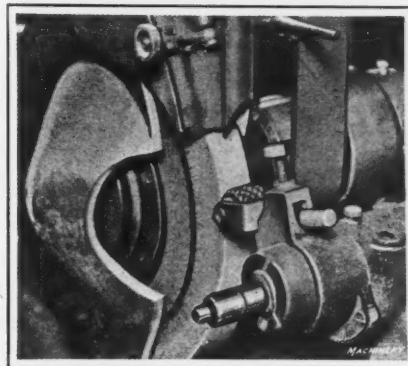
use of tool steel through employing tool-holders, that this new Red-E tool was developed for use on machines of the types to which reference has been made.

ROSS GRINDING WHEEL TRUING TOOL

To meet the requirements of truing grinding wheels used for precision work, the Ross Mfg. Co., Cleveland, Ohio, is making a wheel truing tool which is shown in operation in the illustration. This tool consists of a hardened steel cylinder milled with a succession of slots which break up the sur-

face of the grinding wheel into rows of diagonal squares. This cylinder is mounted on dustproof ball bearings which are furnished with means of adjustment to take up end play, and with provision for adequate lubrication. The hardened steel cylinder and its supporting bearings are carried in a fork made to fit the diamond tool holding fixture on grinding machines. When the truing tool is applied to the grinding wheel there is little grinding action on the tool because both contacting surfaces are running at the same speed; the effect of pressure, however, is to loosen the top layer of blunted crystals so that a fresh lot of sharp crystals are exposed ready to be applied to the work.

Advantages claimed for the Ross grinding wheel truing tool are as follows: The cost of upkeep is small, because there is very little grinding action to wear out the working face of the wheel dresser. Also, it is claimed that a saving is made in the cost of grinding wheels because less frequent dressing is required on wheels where the Ross tool is used, as compared with certain other methods of dressing. It is further claimed that the production



Ross Grinding Wheel Truing Tool in Operation

of grinding wheels trued with this tool is greater than that of wheels trued in some other ways. For instance, it is said that a certain firm in Cleveland using these truing tools finds it necessary on a certain job to redress the grinding wheels every three hours where they were formerly redressed every hour. The time required for the dressing operation averages five minutes, and while the production of each grinding machine was formerly 1500 pieces a day, this production has been increased to 1800 pieces; i. e., a gain of 20 per cent. It is also claimed that harder grades of abrasive can be used because the wheel structure is opened up and does not "load" so readily, and also because the cutting crystals have a keener edge. This truing tool is especially valuable for use on wide faced grinding wheels, due to the fact that it does not heat or chip when held in contact with the grinding wheel for the period of time required to dress a wide faced wheel. These Ross truing tools are made in several grades for roughing and finishing different types of grinding wheels.

DAVIE GAGING MACHINE

To meet all the requirements of the tool-room or inspection department for gaging tool work where the highest attainable accuracy is required, or for the inspection of commercial work where it is only required to maintain the dimensions of pieces within ordinary limits, the Davie Tool Co., 1666 E. 118th St., Cleveland, Ohio, has developed a gaging machine which is illustrated and described in the following article. This machine is so designed that it may be arranged to give readings to three different degrees of accuracy, namely, 0.001 inch, 0.0001 inch and 0.00001 inch, respectively, these different readings being obtained by means of compound levers which actuate the dial indicator. These multiplying levers are accurately balanced and provided with means of adjustment to compensate for any inaccuracy in the fulcrum. Three different mountings are provided on the machine for the dial indicator, which is set in one of these positions according to the degree of accuracy required in testing the work. It will be seen that the test indicator dial is arranged to read plus and minus, so that the amount which work is either over size or under size may be accurately determined. The machine is intended for use in place of snap gages or micrometers, and the makers claim that a gaging device on which the result is visually indicated gives uniform results when used by different

operators, while the "feel" of a snap gage or micrometer involves the personal equation and may vary with different men.

A good idea of the way in which this gaging machine operates will be obtained by referring to Fig. 1 in connection with the following description. Here it will be seen that work *A* to be tested is supported on a gaging table *B*, this table being carried by a vertical column *C*. To provide for adjusting the position of the table for gaging different pieces of work, lever *D* is turned to secure an approximate setting; this lever turns a pinion that meshes with rack teeth cut in column *C*. When the gaging table has been set in the desired position,

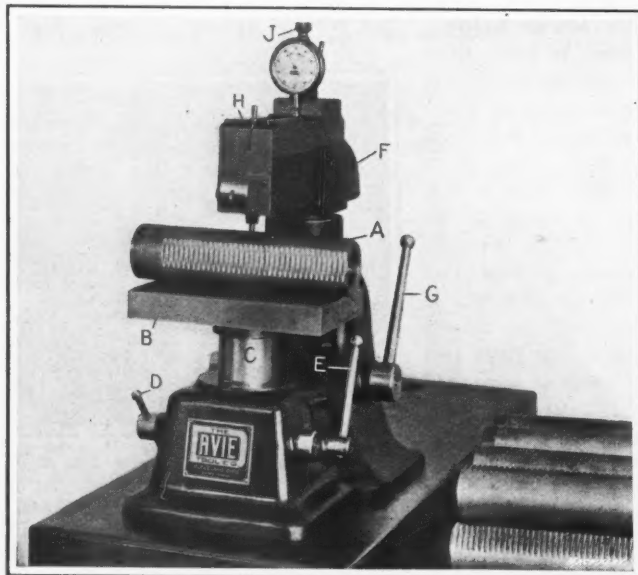


Fig. 1. Davie Gaging Machine with Dial Indicator reading to 0.00001, 0.0001 or 0.001 Inch

the table is clamped by means of binding lever *E*. Multiplying levers that actuate the dial test indicator are contained in case *F*, and the column on which this case is supported may be raised or lowered and clamped in any desired position by lever *G* that actuates an eccentric binding clamp. In Fig. 1 the gaging machine is shown set to read to 0.0001 inch, but by simply removing a screw and placing the dial indicator unit on base *H* in order to bring the indicator into contact with "lifter" *I*, provision is made for obtaining readings to 0.00001 inch. To provide for obtaining readings to 0.001 inch, it is merely necessary to loosen screw *J* and then disengage the indicator and mount it on a stud (not shown in the illustration) which is tapped to receive screw *J*. It will, of course, be apparent that the two chief uses of this gaging machine are for reading to 0.0001 inch and to 0.00001 inch, and, as shown in the illustration for reading to 0.0001 inch, the machine is most useful for the inspection of commercial work.

In Fig. 2 are shown attachments provided for use on this machine for testing the concentricity of milling cutters, gear cutters, etc., and centers for testing the concentricity of arbors, spindles, etc. It will be seen that these attachments are provided with tapered shanks so that they are interchangeable with the regular gaging table. This table is also shown

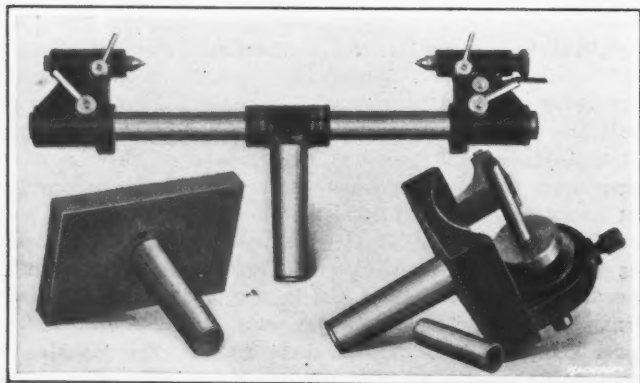


Fig. 2. Attachments for testing Concentricity of Milling Cutters and of Cylindrical Work

in Fig. 2, and it will, of course, be apparent that the tapered shank of either the table or the other two attachments fits into a socket in vertical column *C* of Fig. 1. The top of this column is threaded at the nose and provided with a backing-off nut which is used when a change must be made from the gaging table to one of the attachments, or *vice versa*. The gaging table is made of high-grade tool steel, hardened to a scleroscope hardness of 100, and then lapped to a perfectly flat surface. The balance bearings of the multiplying levers are made of the best tool steel, hardened, ground and lapped.

The principal dimensions of this gaging machine are as follows: distance from center of gaging spindle to back of

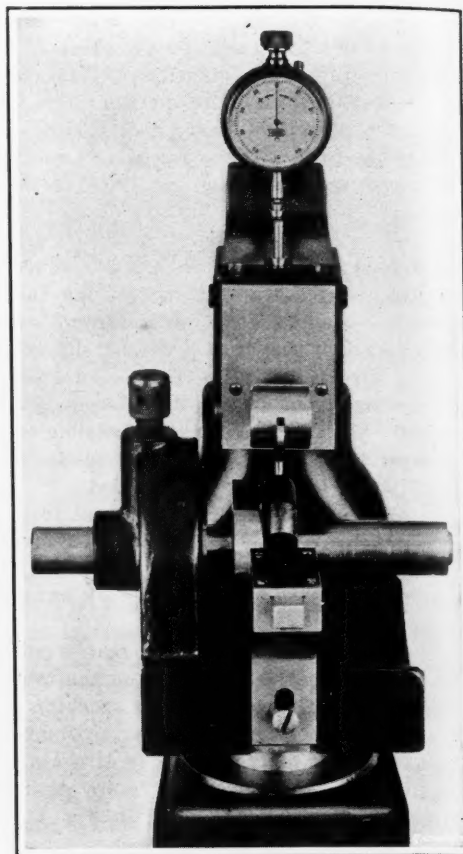


Fig. 3. Davie Gaging Machine with Attachment for testing Concentricity of Gear Cutters, etc., shown in Operation

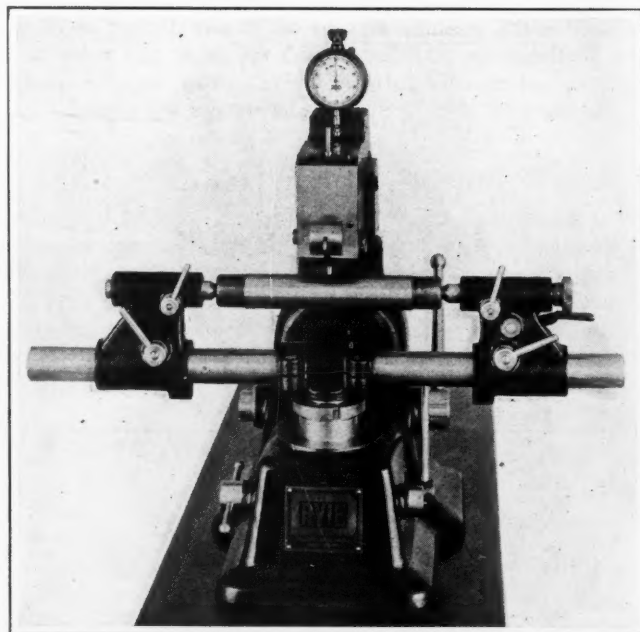


Fig. 4. Davie Gaging Machine with Attachment for testing Concentricity of Cylindrical Work, shown in Operation

throat, $4\frac{1}{4}$ inches; maximum distance from top of table to end of gaging spindle, 4 inches; size of gaging table, 6 by 5 inches; range of adjustment provided for gaging table, 4 inches; vertical adjustment of gage bracket, $\frac{1}{2}$ inch; maximum diameter of cutters or disks that may be gaged for concentricity, 4 inches; maximum distance between centers on attachment for testing cylindrical work, 13 inches; swing of attachment for cylindrical work, 4 inches; maximum height of gaging machine, 18 inches; area of base, 15 by 9 inches; and weight of gaging machine with attachments, 96 pounds.

NEW MACHINERY AND TOOLS NOTES

Quick-action Ball Crank: Cincinnati Ball Crank Co., Oakley, Cincinnati, Ohio. A line of quick-action ball cranks which have the spool or swivel type of handle to allow heavy work to be brought to the proper position with a minimum effort on the part of the operator. These cranks are built in various sizes, the largest having an over-all length of 13 inches.

Ball-bearing Centers: J. A. Moller, 57 Lawton St., New Rochelle, N. Y. These ball-bearing centers have been developed for use on lathes and other machine tools. The revolving center is of the familiar cone shape, and is held in the body by means of a bushing while support is furnished by a three-ball thrust bearing which tends to distribute the radial stresses on the stem.

Oven Furnaces: Tate-Jones & Co., Inc., Pittsburg, Pa. Two "recuperative" gas oven furnaces. One of these is known as a Series A furnace, while the other is designated a Series H furnace. The Series A furnaces are designed for a temperature range from 900 to 1600 degrees F, while furnaces of the Series H type are adapted for temperature ranges from 1600 to 2400 degrees F.

Cone-head Lathe: National Lathe Co., 15 W. Second St., Cincinnati, Ohio. A lever-controlled cone-head lathe built in 18- and 22-inch sizes. The drive is through a three-step cone pulley carrying a 3½-inch belt and double back-gears having a ratio of 3 to 1 and 9 to 1. The machine is also built with a four-step cone pulley and single back-gears having a ratio of 5½ to 1.

Milling Cutters: Bilton Machine Tool Co., Bridgeport, Conn. This firm is now making a line of milling cutters which are made in both plain and form types. This line of cutters includes regular spiral mills, bayonet grooving cutters, cutters for milling teeth in pliers, thread milling cutters for shells, concave cutters and a number of formed cutters for munition work.

Geared-head Lathe: National Lathe Co., 15 W. Second St., Cincinnati, Ohio. Geared-head lathes built in 18- and 22-inch sizes and adapted for either motor drive or belt drive from the line-shaft. These lathes are built with any length of bed from six feet, advancing by intervals of two feet, and they may be furnished with plain or cabinet legs. Either metric or standard lead-screws and gears may be furnished.

Bench Saw Table: S. A. Stewart & Co., 85 Hall St., Waltham, Mass. In the January, 1913, number of MACHINERY a description was published of a bench saw which had just been placed on the market by this firm. Recently a pedestal base and special countershaft drive has been developed for use in connection with this machine, which enables the bench saw to be set up as a floor machine in those shops where such an arrangement is desirable.

Dynamic Balancing Machine: Fitz-Empire Double Pivot Last Co., Rochester, N. Y. This machine is adapted for balancing parts weighing from 5 ounces up to 75 pounds, and machines of larger size could be built to special order. The standard machine weighs 650 pounds and a 1½-horsepower motor is required to drive it. Equipment furnished with the machine includes a balancing arbor, two U-bearings, two floor stands, two marking rests and a driving belt.

Drop-light Extension Reel: Cincinnati Specialty Mfg. Co., Powers and Sylvan Sts., Cincinnati, Ohio. An automatic electric drop-light extension reel which is furnished with a swivel joint to enable one to walk in any direction with the lamp. The cord furnished with the outfit is 25 feet long and it is automatically wound over a spring pulley. The reel is stopped or started in a manner similar to that used in manipulating an ordinary window blind roller. Ordinarily, this reel is attached to the ceiling and connection is made with the electric circuit in the usual way.

Combination Center Drill and Countersink: Apex Drill Co., 2455 McMicken Ave., Cincinnati, Ohio. A combination center drill and countersink which is so designed that it cuts a clearance at the top of the countersunk surface in the work. As a result, a center entering the hole produced by this drill is not directly in contact with the work at the periphery of the hole, and so it is possible to face the end of the work right up to the center without employing half centers or adopting the somewhat difficult practice of partially withdrawing the tailstock center from the work.

Wheel-truing Device: Precision Truing Device Co., 519 Main St., Cincinnati, Ohio. A wheel-truing device which consists of a self-contained electrically driven grinding machine that may either be placed in a holder the same as an ordinary diamond tool, or clamped in any position on the machine that is convenient for the operator. The small grinding wheel used on this truing device is composed of a hard abrasant and the wheel runs at a speed of approximately 8000 feet per minute in the opposite direction to that of the

grinding wheel which is to be trued. The truing wheel is moved across the face of the grinding wheel to be trued in the same way that an ordinary diamond would be employed.

Tool-room Lathe: Rockford Tool Co., Rockford, Ill. A 16-inch tool-room lathe in which the number of controlling levers has been reduced as far as possible. This feature of simplicity combined with a heavy construction are the two outstanding points of the design of this machine. The lead-screw is not splined and a graduated chasing dial hung on a pivot is provided to facilitate the performance of thread cutting operations. An independent feed-rod is furnished and motion imparted by this rod can be reversed by a lever at the right-hand side of the apron. There are thirty-six available rates of feed, covering a range from 0.003 to 0.166 inch per revolution of the spindle. Any number of threads from 1½ to 80 per inch, including the 11½-inch standard pipe thread, can be cut on this machine.

Pneumatic Drill: Ingersoll-Rand Co., 11 Broadway, New York City. A light-weight, high-power, non-reversible drill which represents an addition to the line of "Little David" pneumatic tools of this company's manufacture. The new drill has a capacity for reaming work up to 5/16 inch and for drilling up to 9/16 inch. It is known as a "No. 5" drill, weighs fifteen pounds, and develops a free spindle speed of 1000 R.P.M. The motor is of the four-piston type, and by removing five cap-screws, the entire crankshaft assembly may be withdrawn as a self-contained unit. The valve is of the rotary type and is gear-driven. This machine may be furnished with either a breast-plate, spade handle or a telescoping feed-screw; and where power feed is provided, the maximum length of feed is 2½ inches at one setting.

Heavy-duty Drilling Machine: Defiance Machine Works, Defiance, Ohio. A No. 3 24-inch vertical drilling machine with capacity for driving 3-inch high-speed steel drills in solid steel to the limit of their cutting capacity. Among the distinctive features of this machine the following may be mentioned: Two cones of gears are employed, which are operated by a lever to provide the feed changes, while the spindle speeds are secured through two cones of gears and a roll-in gear. A gravity oiling system is employed with special provision to guard against unnecessary use of oil. The machine is equipped with a single driving pulley belted direct to the lineshaft and eight spindle speeds are available, ranging from 51 to 408 R.P.M. Four feed changes are provided, covering a range from 0.046 to 0.007 inch per spindle revolution, and the feed is transmitted to the spindle by a large worm-gear which runs in an oil bath. Power feed is available through a maximum spindle travel of 16 inches.

AMERICAN CORPORATIONS IN NEUTRAL COUNTRIES

The War Trade Board has authorized branches of American corporations and other American houses established and engaged in business in neutral countries and in countries associated with the United States in the war to accept and pay drafts, to deliver goods, warehoused or otherwise stored, and to perform other similar acts, notwithstanding that such acts may involve trading with "enemies" or "allies of enemies," when such acts are necessary to prevent a breach or violation of a law or commercial obligation enforceable in the courts of the country in which such branch is established; provided, however, that nothing herein contained shall be held or construed to authorize said corporations, houses or their branches to hereafter undertake or enter into contracts or business or commercial transactions which will involve trading with "enemies" or "enemy allies" in order to carry out or perform the same; and that every case involving transactions of trading with the "enemy" or "enemy allies" be reported to the War Trade Board within thirty days after the occurrence thereof, upon a form to be furnished by the War Trade Board.

OLD TRACINGS ASKED FOR BY RED CROSS

The American Red Cross requests manufacturers and others using tracing cloth to donate discarded tracings to the Red Cross. The tracings are washed and the material—linen or cotton—is employed for the making of surgical dressings to be used in the field hospitals. The Red Cross has made arrangements with large laundries in all cities to collect material of this kind, and any manufacturer who wishes to aid should call up the local Laundry Owners' Association or one of the large laundries in his city, who will send for such material as he will give them.

READJUSTMENT AND OPERATION OF INDUSTRY IN ENGLAND SINCE 1914

The Merchants Association of New York has published a report dealing with the statements made by the special commission from the British Ministry of Munitions which visited the United States in the latter part of the past year with a view to giving manufacturers in this country the benefit of the experience of England in munition industries since the outbreak of the war. Although the representatives of the commission did not offer advice, the information given should prove of great value to employers at this time, when so much depends upon the successful solution of our industrial problems.

Agreement between Government, Manufacturers and Labor Unions

All legislation in Great Britain relating to the regulation of manufacture and labor since the beginning of the war has been the result of agreement between the government, employers, and labor unions, and covers practically everything that is manufactured for war purposes. There is not a single clause in the legislative acts that has not been the result of discussion and agreement between the three interests mentioned. The principal features of the legislative acts that have been passed are given in the following paragraphs.

Power of Ministry of Munitions

The Minister of Munitions received power to control factories engaged principally on the manufacture of munitions. The control of these factories amounted to a right of the Minister of Munitions to take over the plant altogether from the owners. That right has been rarely exercised, and exercised only when the management failed to comply with the requirements of the government. Such cases have been exceptional, probably only two or three in number. As part of his powers in regard to these factories the Minister of Munitions has definite authority to limit the profits of such plants. The profits were limited to an increase of one-fifth over an average of the profits of the two years preceding the war.

The trade unions agreed that, in view of the fact that a definite limitation had been put on profits, the wages of the employees should be fixed at the rates which existed at that time. There was to be no fluctuation upward or downward in the wages except by consent of the Minister of Munitions. It was agreed that neither capital nor labor should make a profit out of the nation's needs. The government, having fixed wages, appreciated that it became its duty to see that the labor so dealt with should not suffer from the increased cost of living. It set up a Committee on Production. One of the duties of this committee consisted in hearing evidence as to the increased cost of living three times every year. Evidence is brought before it by trade unions' officials, or anyone concerned, and the committee has all the government statistics in regard to the increased cost of the necessities of life. Assuming that the living costs have gone up, the committee then makes (in the nature of a war bonus) a national award to all employees on war work payable by the employer, but to be recovered from the government.

Strikes and Lockouts

Strikes and lockouts became illegal and arbitration became compulsory. It was agreed that any trade disputes in war industries should, for the period of the war, be submitted compulsorily to arbitration, which the government should arrange. The government took the view that it could not tolerate interruption of supplies resulting from differences between employers and employees. It took the view that its duty was to interfere between the employers and employees to prevent interruption of supplies vital to the success of the armies. The government viewed this matter with such gravity that power was granted to imprison for life anyone who incited to strikes or interfered with the operation of the agreement. It has never become necessary to enforce this penalty. Public opinion has generally enforced the act very effectively.

Limitations of Rights of Labor Unions

The trade unions agreed to waive all their practices and customs which tended to restrict either employment or output, such as the employment of only union labor, and the use of only skilled persons on skilled jobs; and they promised to do their utmost to see that that agreement was carried through. They agreed also that any person, man or woman, would be allowed to do any kind of work. In return for these important concessions the government pledged itself to restore pre-war conditions in shops after the war. The trade unions, their leaders, and the rank and file, have abided loyally by that agreement and act.

Compulsory Arbitration

The first Munitions of War Act set up machinery for compulsory arbitration. Despite this system of compulsory arbitration, it would be misleading to say that there have not been labor troubles or strikes, but there have been only three strikes which have had to be regarded as serious, and of these none has lasted more than a week. Not a strike has arisen for higher wages since the war began. Moreover, there has not been a single strike in which the responsible trade union officials have not stood side by side with the government and done their utmost to bring every man back to work at the earliest possible moment. One of the lessons which has been learned in England is that the war is a war of the civil organizations—of mechanism and mechanics, of the machine shop and the factory—just as much as it is a war of the army. Organization of industry at home must be as complete and thorough as at the front. If one leaves organization at home to chance, he imperils the army. Industrial peace at home, continuity of supplies, and ever-increasing output—these things are vital if this war is to be won without useless waste of life and supplies.

Prevention of Shifting of Labor

The shifting of labor from establishment to establishment, from work of great importance to work of less importance, from war work to civil work, has been checked by a system of licenses. No non-essential industry which uses materials essential for war purposes or employs labor which could be used in the manufacture of munitions now exists in England. Therefore there is little risk of labor, which is engaged in the manufacture of munitions, leaving for civil work. It was soon found in England that some manufacturers had taken on orders that could not be filled without a large increase in their labor force. Accordingly, such manufacturers had set about getting the necessary workmen in the most uneconomic way possible; that is, they tried to get labor from other plants. A system of labor auctioneering and enticement was found to be going on all over the country. This situation was ended by two regulations under the Defense of the Realm Act, which stated in effect that no employer in the engineering industry (machine shops and other metal-working plants) should offer an enticement or endeavor to entice away an employee from any other employer in that industry. Should he do this, he was liable to a heavy penalty. Further, the Ministry of Munitions was empowered to regulate and restrict the employment of labor in any factory. If an employer offers an enticement to other labor, or if he is found using the labor he has in an uneconomic way (holding labor for future contracts or using a skilled man on a machine which a less skilled man could operate), an embargo is laid on that firm and it is not permitted to engage any labor of any sort except under license from the Ministry of Munitions. In this way a plant can be watched and the man-power in that plant can be economized as much as possible.

Hours of Labor

In England there are no regulations or laws as to hours of labor. This matter is always dealt with by means of agreement between the trade unions and the employers' federations. The only alteration that has been made during the war is that the hours which a woman might be worked were limited to sixty per week. There is no over-time limit for men. In general, the normal hours actually worked at the present

time in England amount in the metal trades to about fifty-four to fifty-six per week for men and fifty-two to fifty-four hours for women, with perhaps four to six hours over-time for men and one to four hours over-time for women. In an explosive factory women usually work forty-eight hours.

There was a period when England worked her men and women perhaps one hundred hours a week. There was an initial output during the first four to six months which was larger than was expected; but after that it began to decrease to less than that of normal hours. As a result, an effort has recently been made to cut down the excessive hours and to get rid of over-time as much as possible. All Sunday labor, except on continuous processes, has now been done away with. Similarly an effort has been made to abolish over-time or to reduce it to a minimum. The obstacle in the way of any further reduction is not on the part of the government, nor employers, but because the workers desire to earn extra pay.

War Munitions Volunteers

The War Munitions Volunteers system has been of tremendous assistance to England in stabilizing the labor supply and in controlling priority of labor on war work. The War Munitions Volunteers are skilled workmen who have offered their services to the Ministry of Munitions for the duration of the war. They constitute a mobile force—now numbering about 200,000—which can be shifted into any form of munitions work that the Ministry considers especially vital at any given time. Workmen have become members of the War Munitions Volunteers because of the appeal of patriotism and because membership carries with it exemption from military service. Members receive the established rate of pay in the plant which they leave, or the plant to which they go, whichever may be the higher. The formation of the War Munitions Volunteers system has produced many of the beneficial results of industrial conscription without any of the dangers. The government can now select men scientifically whenever there is special need of additional skilled workmen in any factory or in any district, and these men can be taken from work on which their loss will be felt least.

* * *

TREATMENT OF WOUNDS DUE TO INDUSTRIAL ACCIDENTS

The so-called Dakin's solution, an antiseptic which has been developed in Paris in connection with the treatment of wounded soldiers, will find a valuable application in the treatment of injuries due to industrial accidents. The solution has been tried by the medical departments of a number of industrial plants in the United States, and the report of its successful application in the dispensary of the General Electric Co. at West Lynn, Mass., has brought out some interesting facts. The works' physician, Dr. Frank E. Schubmehl, makes the following statement relating to its use:

All wounds occurring in this plant are considered infected wounds at the very beginning and are treated as such. A dressing is applied over the wounded area in such a way that the denuded or exposed tissue laceration is free from pressure. First, the wound is thoroughly, but carefully, cleansed with Dakin's solution, either by spray or swabbing off with cotton. Pressure is made around and about the outside edges of the wound, previously covering the uninjured parts to be included in the bandage with vaseline gauze. The bandage is then applied and the patient is instructed to pour through the depression in the bandage, where the opening of the original dressing appears, enough of the Dakin solution, every two hours, to thoroughly wash out the chamber within. The patient is supplied with a bottle of the Dakin solution sufficient to carry him over to the next dressing. When the injury is a small one, the dressing is applied as above, and the patient is supplied with a medicine dropper, in addition to the bottle of the solution, and is instructed about the use of the solution.

From an observation of 6000 injuries, large and small, at the General Electric Co.'s plant since the introduction of this treatment, it is believed that the method described is the most efficient that has been developed. Several cases of lacerated fingers and of compound fractures of the bone have been treated by Dakin's solution, and the partially severed members held only by a slight piece of integument have been saved.

JOBGING-SHOP PRODUCTION

BY CHARLES A. CARPENTER¹

The jobbing machine shop offers problems in production that are, in general, much more difficult than those of manufacturing establishments. In the latter, machinery is installed to perform certain definite functions. Great ability is needed in designing and selecting this machinery, and a versatile repair gang is indispensable to maintain full output; the actual production work then becomes simple. In jobbing shops, the work taken must conform to the limitations of the equipment. It is impossible to secure work to keep all machines working equal hours; hence two problems confront the jobbing-shop manager. He must balance the work ahead of all machines by careful sales and strict attention to scheduling production, and he must increase the utility of machines by cheap alterations, fixtures or other accessories. The installation of new equipment requires shrewd judgment mixed with plenty of gambling faith, and the repair gang should be in charge of a mechanical genius who is an all-around machinist.

In order to get the best results and the largest profits from a shop taking special contract work, it is necessary to keep all equipment equally busy on operations suitable for the machinery involved. To secure these results it is necessary to keep a complete and detailed record of all machinery and small tool capacities. Thus a lathe record should accurately show the diametral and length limits, thread-cutting capacities, accuracies, etc. The importance of this information is easily shown. Suppose a long shaft is to be turned to close limits. While more than one machine may be satisfactory for swing and length, only one may be sufficiently accurate to turn to the size wanted. Some lathes turn out of round, some show chatter marks on the work, and some may not have thread-cutting capacities for the full working length. It may often be essential to have an extra length on long shafts for driving so that threading or other special work may be done at the headstock end. A little experience in jobbing work, carefully recorded, will quickly enable an alert superintendent to secure the necessary data on small machinery and small tools. In addition, a critical study must be made of all blueprints issued to the shop to determine the proper assignment of work to each machine. This problem requires intimate knowledge of the capacities of the machines and an understanding of the complete shop routing system. For example, some work is taken that must go on one particular machine; other work might be handled equally well on two or more machines.

The first step in the proper assignment of work is to list definitely all jobs that any one machine must handle. For instance, assume that a shop has several planers: one taking work 10 feet wide, another work 8 feet wide, and a third work 7 feet wide, etc. Any planer work over 8 feet wide should go on the 10-foot planer unless special rigs are available for one of the smaller machines. After he has scheduled for the 10-foot planer the work it should take, the superintendent may find that this machine has more work than it can complete in the time desired; or that it is just properly balanced with the other equipment; or that it has too little work ahead. Each condition must be considered in connection with the entire production system. If there is apparently too much work for the time available, one solution of the difficulty is to ignore promised deliveries and let each job take its turn; that is an admission of failure. Another plan is to make a close study of one of the smaller machines to see if a special set-up will take care of one or more of the jobs. A third plan is to run the 10-foot planer extra hours. Sub-letting part of the work might be desirable. If the work ahead is just right for the shipping schedule, no adjustment is necessary unless caused by overcrowding of other machines. Should there be too little work ahead, other tools might be relieved so as to balance working hours, or part time might be advisable. When considering work suitable for two or more machines, an effort should be made to assign work to secure the lowest costs and at the same time to balance the equipment in so far as is practicable.

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Advantages and Disadvantages of Routing Work

It is frequently necessary for the superintendent to decide when the routing of the work should be changed. Men who have never handled a jobbing shop may say that no interference of schedule should be permitted, while most jobbing-shop foremen will say no schedule is worth anything because it cannot be kept. While a shop taking special work cannot develop a routing system that will eliminate the disruption of schedule plans, tentative schedules of the work should always be made. Schedules must frequently be broken, because it is impossible always to estimate correctly the time that will be required to do a job never before attempted. Besides, the amount of finish and the character of metal may render ineffective estimates based on past performances; breakdowns of equipment cannot be entirely prevented; defective material is frequently manifest only after considerable machining; desirable contracts may be taken with the full knowledge that schedules will be broken; and cancellations, "hold-up" orders and requests for deferred shipments may justify a schedule change.

The reasons in favor of making tentative schedules are just as numerous. By carefully studying the work ahead of each machine, a larger output is obtainable because the tendency is to keep all machines equally busy, and by studying routing, new methods will come to mind. A much closer watch is kept on shipping dates, improving the reputation of the firm; oftentimes desirable contracts may be taken for quick delivery that otherwise would be lost through haphazard delivery promises. The importance of hurrying in materials purchased outside is clearly brought to mind. The most important reason for making a tentative schedule, however, is the better grasp it gives the superintendent of the problem of production. An executive properly in touch with his shop can head off undesirable contracts.

Obtaining Mechanism Output with Greatest Efficiency

For keeping the records of machine and tool capacities, a card file is preferable, the cards being grouped according to machines, such as lathes, planers, horizontal boring mills, taps, drills, boring heads, etc. A volume might be written about the information that should be kept on these cards, but any practical shop man can start such a record and every new job will afford information on the limitations of the equipment. Before a person will have kept his file many weeks, he will be surprised to find the number of jobs that have been done at low cost on tools that, before the file was kept, were considered unfit for that purpose. As a result, the shop will be running nearer to 100 per cent capacity than ever before. Few machinists realize how many things a good machine tool can do, so that it is only by a careful study that the full range of capacity can be determined. But such a study will show that many jobs formerly assigned to a very few machines may be done with commercial efficiency on many others by inexpensive special rigging. The accumulation of this rigging also helps the management to obtain 100 per cent output.

To avoid dependence upon memory, a route sheet should be kept of every machine or small tool that may at any time become overscheduled with work. Thus there should be a sheet for each lathe, planer, vertical mill, etc. Then an examination of a new drawing will suggest assigning one job to, say, an 8-foot planer, another to a 42-inch lathe, a third to a 9-foot vertical mill, and a fourth to a 6-foot radial drilling machine. The complete sheet for each machine will show several jobs ahead, giving the shop order numbers, bill of material, marks or pattern numbers, descriptions of the pieces, operations to be done, approximate number of hours required for each, and the tentative date of completion. From these routing charts, it is comparatively simple to select the jobs that should be taken up as each preceding job is completed. To decide the order of future assignments, an analysis must be made to determine if work should be shifted from one machine to another, if material will be received in time to keep schedules, and the importance of keeping previously promised delivery dates.

With adequate information available, it is best to note a tentative sequence for the jobs ahead of each tool. Frequent

conferences of the shop executives will enable the management to change this arrangement readily to meet new conditions. Should it be impossible to take up any job in its turn, it is generally better to take the next one in order, leaving the delayed job for future consideration. Definite instructions should be issued whenever this procedure is desirable, and the foreman in charge should be advised, should it be decided to hold any machine waiting for its scheduled work.

Because of the many factors that enter into the work, the man in charge of production in a jobbing shop must always be "on the job." He must clearly understand the shop's limitations and possibilities. He must be conversant with the status of each contract and must be ready to have each day start his problems anew. He cannot feel any sense of permanency in the plans made and yet he must have faith in those plans when made. With these characteristics mixed with practical judgment and ingenuity, a production man can maintain a high state of efficiency in his plant and he will be rewarded by securing a greater output, lower costs, and better deliveries than he ever thought possible.

* * *

CONVENTION ON FOREIGN TRADE

The Fifth National Foreign Trade Convention will meet at the Gibson Hotel, Cincinnati, Ohio, Thursday, Friday and Saturday, April 18-20, inclusive. The theme of the convention will be "The Part of Foreign Trade in Winning the War." In the formal call to the convention, James A. Farrell, chairman of the National Foreign Trade Council, calls attention to the fact that American participation in the war against Germany has laid a new obligation upon the foreign trade enterprises of the United States and at the same time presented a new opportunity. The object of the convention is to consider that obligation and that opportunity; to discuss the different elements of foreign trade; and to give serious thought to the demands and the problems of the future.

All Americans engaged in, or desirous of entering overseas commerce, and especially all chambers of commerce, boards of trade and other commercial and industrial organizations, as well as firms and individuals, are invited to take part in the convention, individually or by appointment of delegates. The discussion will be led by men who are foremost in the foreign trade experience of the United States. Approximately one-half of the time of the convention will be given to the presentation of papers and reports dealing with one or another of the numerous phases of the convention theme. The remainder will be devoted to group sessions for the discussion of single problems under the leadership of specially qualified experts.

* * *

NEW CLUB HOUSE OF DAYTON ENGINEERS' CLUB

The Engineers' Club of Dayton, which was organized in February, 1914, for the purpose of advancing the engineering knowledge and practice and the professional standing of its members by means of meetings for the reading and discussion of appropriate papers, as well as by the opportunity of social and professional intercourse, has recently erected a large club house in Dayton, which will be dedicated on Saturday afternoon and evening, February 2. The membership of the society is about three hundred, Colonel A. E. Deeds, chief of the Aircraft Production Board, being president. The new building is located at the southeast corner of Monument Ave. and Jefferson St., facing 150 feet on the avenue and 125 feet on Jefferson St. It is three stories high and contains, in addition to the regular club house accommodations, an auditorium with a seating capacity for 450 people. The building and grounds are the gift of Colonel E. A. Deeds and Charles F. Kettering, members of the club.

* * *

CORRECTION

The formula on page 455 in the January number of MACHINERY, left-hand column, should read:

$$K = D \left(1 + \cos \frac{A}{2} \right) - \left(\frac{P}{2} \cos \frac{A}{2} \right)$$



Fig. 1. Gas Furnaces for melting Stellite in Crucibles

NOTES ON THE MANUFACTURE AND FABRICATION OF STELLITE

Some years ago Elwood Haynes, of Kokomo, Ind., the metallurgist and engineer, discovered that an alloy of cobalt, chromium and certain other metals resisted oxidation indefinitely at all ordinary temperatures. In these experiments Mr. Haynes was intent on finding an alloy that could be used as a substitute for tableware silver. He was successful in producing an alloy that resisted the acids of apples, lemons, grapefruit and other common fruits and foods. In the course of his investigations he discovered another alloy of much greater interest and value to the engineering world, which also is a compound of cobalt and chromium with certain other metals, such as tungsten and molybdenum. This alloy, called "stellite" because of its starry and untarnishable luster, was found to be the most efficient metal for cutting tools, especially lathe tools. In fact, stellite is in a sense a revolutionary discovery, as it makes possible the machining of metals at speeds impossible of attainment with any known high-speed steel. The scarcity of tungsten, and the resulting scarcity of high-speed steels containing tungsten, has given a great impetus to the manufacture of stellite. The object of the present article is to give an idea of the general processes of producing it and fabricating it into cutting tools.

The cobalt, chromium and tungsten are reduced from their native ores in the Kokomo plant and are mixed in the various proportions required for the different grades required. Stellite has a high melting point, requiring a temperature of about 1930 degrees C. (3506 degrees F.) to render it sufficiently fluid to flow; but even when raised to this high temperature it does

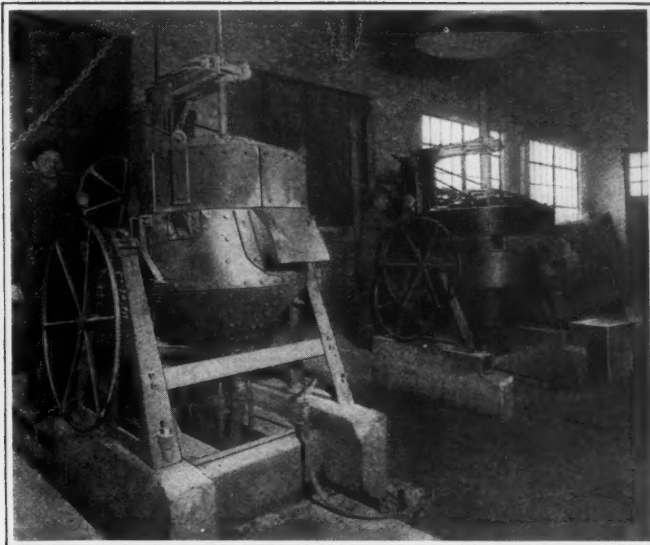


Fig. 2. Snyder Single Electrode Furnace in Position for melting Charge

not flow the same as molten cast iron, but rather like a thick syrup. Because of this peculiarity, some difficulty is experienced in casting stellite in any but the simplest forms.

Two types of melting furnaces are used, electric and oil gas. The Snyder electric furnaces, which are of the single electrode type, require about 25 minutes to melt a charge, while the gas furnaces shown in Fig. 1 require about 1 3/4 hour. The gas furnaces are also at a disadvantage because they require the use of crucibles, which have been nearly unobtainable, and of poor quality and high price since the outbreak of the war. The electric furnace hearth is lined with magnesite and the cost of lining is less than that of crucibles required for an equivalent output.

The Snyder electric furnace has a vertical carbon electrode mounted in the center above the hearth. The arc extends from the electrode, and the heating takes place by means of radial conduction and resistance. When the stellite is melted, the furnace is tipped forward on its trunnions and the charge poured into a large crucible. The pouring crucibles are filled from the large crucible, great care being taken to skim off all oxidized and foreign matter. Stellite is molded for cutting tools into bars of varying cross-section, according to the size and weight of the tool-bit required. The molds are made of graphite slabs held together by C-clamps, as shown in the foreground of Fig. 1. These molds are planed on a shaper, the grooves being cut to form the cross-section required when the two halves of the mold are matched together. When pouring the metal, the utmost care must be taken to skim off all dross and slag, but notwithstanding the care taken, a considerable percentage of the bars cast are found defective on test and must be rejected. These are broken up and remelted with

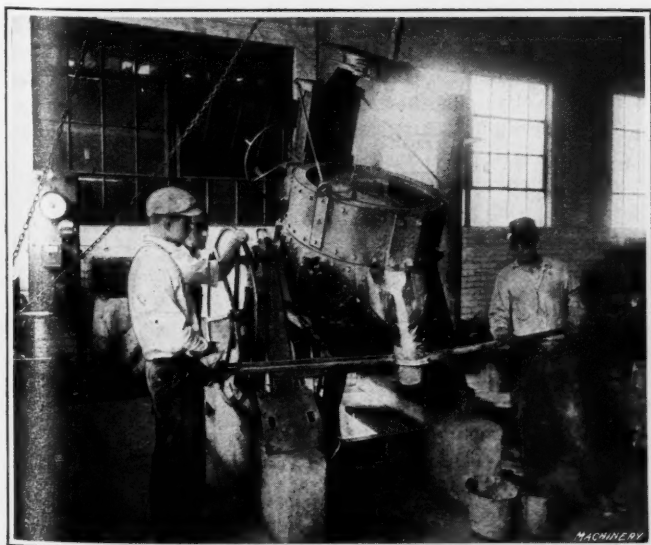


Fig. 3. Snyder Furnace pouring off Melted Stellite Charge

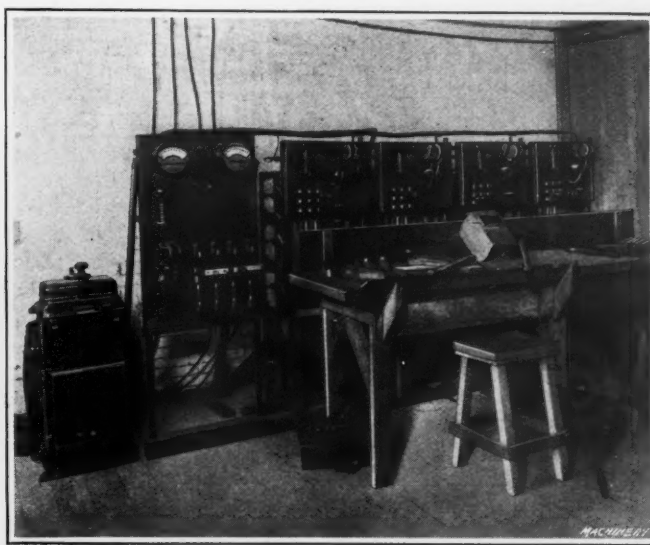


Fig. 4. Electrical Equipment for welding Stellite Bits to Steel Holders

additional cobalt, chromium or tungsten required to produce the grade of stellite desired. The stellite bars are fabricated into tool-bits for lathes and planer tool-holders, and are electrically welded to machine steel shanks, thus making the cutting point integral with the shank. All forming is done by grinding, as it is impracticable, if not impossible, to machine it. No method is known by which it can be annealed.

The electric butt-welding process is used successfully for welding stellite to the end of machine steel shanks when the cross-section of the bit and the shank are the same. The electric arc process is preferred for welding points to holders when the bit is of a smaller cross-section than the holder. The shank is notched to receive the bit, and the "saddle" is beveled at each side. The stellite bit is also beveled on the lower sides, as indicated at A in Fig. 5. The beveling is done in order to

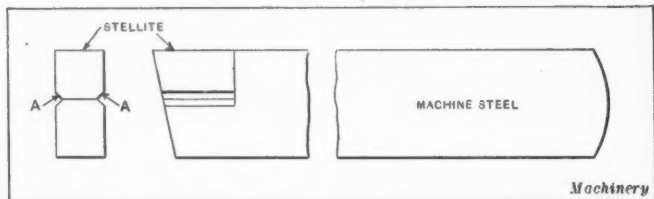


Fig. 5. Stellite Bit and Machine Steel Tool Shank Ready for Welding

secure a more satisfactory weld. The bit is first "tipped" in place with the electric arc and then the V-grooves are filled in flush with stellite, thus forming a solid union with the shank. The object of sloping the sides of the saddle is to insure a solid, dependable stellite cutting material clear down to the machine steel beneath. It was found that if the saddle was not sloped, the steel and stellite alloyed during the melting process and produced an inferior cutting tool when nearly ground away. This trouble is entirely eliminated by the present practice, which insures to the customer the full value of his investment.

F. E. R.

THE LIBERTY MOTOR

At the annual convention of the Society of Automotive Engineers, held in New York City January 9 and 10, one session was given over to the discussion of the Liberty motor, at which time some interesting facts not previously published were brought out. The Liberty motor embodies the best principles of foreign aeronautical motor design, combined with the experience of American builders of automobile and airplane engines. It is intended for fighting planes, and can develop 400 horsepower on the ground. It has twelve cylinders, and its weight is 800 pounds, or approximately two pounds per horsepower. The main considerations in its design were to produce an engine that was compact, had a small number of parts and was reliable. In fact, reliability was made the prime consideration, and hence no experimental features have been included, but only such points are embodied in the design as have been thoroughly tried out in the past. The engine which, during the past year, has been most commonly used in airplane service in Europe develops from 200 to 220 horsepower on the ground and weighs 520 pounds. Hence the Liberty motor is a distinct advance for high power and proportionately reduced weight. The Army machines are not provided with self-starters, as the engine cannot be stopped after it has left the ground, unless, of course, subjected to such an accident that even the self-starter would be without avail. The motors for the Navy airplanes, however, are provided with self-starters. The ignition is by means of dry batteries, the ignition equipment, complete, weighing only 29 pounds. This method of ignition was selected because of being the lightest equipment obtainable in combination with reliability. The cylinders are set at an angle of 45 degrees with each other. The piston clearance is 0.020 inch at the lower end of the piston. Pressure fuel-feed is used, and the carburetor is manually controlled. Mineral oil is used for the lubrication, but castor oil is preferred.

During the discussion, an interesting fact relating to the life of airplanes was brought out. It was stated that fighting machines have a life of about 100 flying hours, equivalent to

about two months of service. An observation plane has a life of about three months. Bomb-dropping planes used for flying only at night, and hence being more immune from attack, are likely to have a longer life. In speaking of the life of an airplane, it is not intended to convey the idea that any of its working parts are worn out, but simply that, on an average, the plane meets with an accident or is brought down by the enemy after the period mentioned.

* * *

GROUP INSURANCE AT THE CINCINNATI PLANER CO.'S PLANT

BY A. J. SCHNEIDER¹

As many employers are now studying methods tending toward decreasing the labor turnover and increasing production, the following description of the group insurance method used by the Cincinnati Planer Co., Cincinnati, Ohio, may prove of interest. The object in adopting this method of insurance was to make this plant a desirable place to work in, so that the labor turnover would in that way be decreased. The insurance having been in effect only since October, 1917, it is too early to state positively whether the expected results will be forthcoming or not. The average cost is about \$4 per year per employee, or about 1 1/3 cent per working day, the actual cost in each case depending upon the age and length of service of the six hundred employees covered by the insurance.

In starting the system, a letter was typewritten on the company's regular stationery addressed to the employees of the Cincinnati Planer Co. and stating in plain terms the object and conditions of the insurance. The letter was mailed on a Friday, so that it would be received on Saturday, which would give the men an opportunity to talk the matter over with their families during Saturday afternoon and Sunday. In the employment department an immediate increase in the number of applications was noticeable.

The insurance includes the following details: Those who have been in the company's employ for three months are insured for \$500; those who have been in constant employ for six months, for \$600; those who have been continuously employed for one year, for \$700; and for every additional year of continuous employment another \$100 is added to the insurance, until a maximum amount of \$1500 is reached. The company pays all premiums, no deductions from wages or contributions of any kind from the employees being required. In addition to offering a life insurance protection, the insurance also provides an income in case of permanent disability, whether resulting from disease or accident.

One part of this proposition which received considerable study was the question as to whether the amount of the insurance should be based on wages or on length of service. It was decided that the latter plan was simpler and more efficient, for several reasons. In the first place, there is a specific advantage in remaining with the company, as the insurance increases with length of service. Hence there is an incentive for remaining with the organization even if some other concern should also adopt an insurance plan, because the new employee with another concern would be likely to be insured for a smaller sum than the insurance carried if he stays with the old concern. Another advantage of basing insurance on length of service is that it is very simple and leaves no room for doubt. Insurance based on wages requires considerable computation in order to be equitable under the present premium, piece-work and bonus systems. It might also create dissatisfaction among the employees, as the size of the insurance policy would be a measure of the wages received.

The work required in connection with the insurance plan is simple and requires very little time, probably not more than two hours a week for a force of six hundred men. Of course, at the inauguration of the system a record card giving complete information about each employee must be filled out, stating in full the name of the company and employee, date of birth, address, beneficiary, etc.; afterward, however, no further work is required unless the employee leaves the company or dies, except for the checking of invoices and reports, which can be handled by a very simple system.

¹Employment Manager, Cincinnati Planer Co., Oakley, Cincinnati, Ohio

OBSERVATIONS AROUND THE SHOPS

BY DONALD A. HAMPSON¹

We were passing in the rear of one of the buildings of an up-state specialty foundry while several men were cleaning out the cupola. "See that slag pile?" said the proprietor. "Well, we used to dump all of that stuff over there in the swamp, but we don't do it any more. I attended a foundryman's convention in Boston four or five years ago and saw a process for working over cupola cleanings—wouldn't have believed it possible unless I had seen it—so I put in an order for a machine on the spot and learned just how to do everything before I left. Now, we wash the slag and run it through the machine and we have been reclaiming five tons of good iron a week. That's a pretty good saving for a foundry of this size and with the pig where it is today, you can imagine what a nice percentage that Boston trip is paying."

Maintaining the Proper Speed for Grinding

The grinding room of the same foundry had a good scheme for keeping the emery wheels always running at a nearly correct surface speed. The machines were equipped with the best of hoods and exhausters and the work was wide or long enough so that, if held straight, it would not pass between the sides of the hoods. New emery wheels were twenty inches in diameter and the hood on the first machine was cut so that by the time the wheels were worn down to seventeen inches the work struck the hood. The wheels were then changed to the next machine and worn to fourteen inches, and so on. Each machine was belted to give a fair average speed for its wheels.

Reversing a Steam Engine

It was at a rather unfortunate time that the writer visited the paper mill down on the river road. The boss was storming, and didn't want to see anyone, naturally enough, for the help were all standing around idle and not a wheel was turning. Dry weather was the indirect cause, though the machinist who had just been fired was at the bottom of the trouble.

The mill was run by waterpower but it had a steam engine to hook up in case of emergencies, which had been so rare that the engine had not run for ten years. During that time, the machinery had been changed so that the drive from the engine would have to be in the opposite direction. Foreseeing this while the drought was still young, the boss had taken up the matter with the machinist, who was also the engineer to be, and learned, almost against his will, that reversing the engine was a matter of a few minutes and could be put off until steam was up. Well, steam had been gotten up that day and on starting up the engine it had run in the same old direction. Easiest thing in the world to fix! Two men had been put at the flywheel and a man on each of the big pulleys upstairs with instructions to "swing her over good and lively when I shout—and when you get her started backward I'll give her steam and we'll be all right." Repeated attempts had failed to turn the trick and the machinist had been asked to leave for other fields, carrying a blessing with him.

A Newspaper Job

There was as great rivalry between the *Times* and the *Argus* as between any of the papers on Park Row, and every second counted in getting the paper on the street after the last dispatches were in. In the final work of putting the forms on the press, four tap bolts had to be inserted and tightened. To make this a quicker job, the heads were rounded and a strap wound on them; then when the bolts were inserted, the pressman gave the strap a pull, as a boy does a top, and a second was saved that would otherwise have been spent in screwing the bolt in its inch of threaded hole.

It Can't be Done

The hardest thing to combat in bettering a manufacturing process is the spirit that opposes any movement because it was never done before or because the individual never knew

it to be done. Such was the situation at the Ultra Tool Works. The trouble was in the grinding department: the men wouldn't stay or they were always behind and the other departments had to wait. The men sat in rows on boards over the tops of the grindstones and ground as best they could in that awkward position. They were covered with mud from head to foot and wore leather breeches to keep from getting soaked; the windows were also covered with mud. If they hadn't done it that way in England, perhaps they would have started it differently in this country, but once started with some is to go on to the bitter end. No one could blame the workmen for disliking their working conditions, and it had been determined experimentally that the grinding could be done on emery wheels with men working in a natural position and under healthful conditions. This experimenting, of course, had to be done outside, but the management took the stand that such methods would not stand the test of time, as had the old way with Ohio sandstones, and moreover the emery wheels were too expensive. And yet every time they put on another grindstone, the total handling from car to scrap pile cost from \$10 to \$14. Yes, the Ultra failed several years ago.

Building Their Own

"Come in here and I will show you the design of a machine we're going to have built to stamp our parts," said Mr. Hessler. The shop made hardware specialties and had heretofore stamped the name on by hand. "We had thought of buying a Bliss press but they cost \$600 so Harry laid out this machine and it isn't going to cost us more than half of that." Harry was an electrician who had bluffed his way into a created position of mechanical engineer. The design was good, but by the time the patterns had been made, the machine work done and Harry's time added in, \$500 would hardly pay the bill; yet any number of second-hand No. 18 Bliss presses, which would have been heavy enough, could have been purchased for \$150 each.

Machinery in Duplicate

Montrose is not a manufacturing center so when Mr. Aaron Bloomstein appeared before its Board of Trade with a proposition to establish a plant for making his patent lock washer and nut combined, he was gladly received and a committee lost no time in soliciting the funds required to buy the patent (first) and to equip a plant. Montrose is a residential village. Its business and professional men and the farmers close by are well to do and they all welcomed the chance to get an industry, such as this promised to be. Come to think it over, they could remember instance after instance where a nut had come loose and caused disaster, so why shouldn't a factory to make "safe" nuts pay?

Mr. Bloomstein had been a tailor in his early days but had given that up when he invented this nut and made a study of manufacturing processes; this proved him to be the logical man to buy the machinery and start the plant going. Many novel ideas of Mr. Bloomstein's were to be seen when the appraisal was being made after the failure of the Safe Nut Co. which followed Mr. B's unexpected departure with his family, mostly salaried officers of the concern. But most novel of all was the double row of machines down every aisle—machines in duplicate, Mr. B had called it and no one had ever questioned his statement that all progressive plants are run that way. "It's the surest kind of a guarantee against manufacturing losses, for whenever a man breaks a drill or his spring coiling machine clogs, all he has to do is to swing around in his seat and there is a duplicate machine ready and waiting to be started on the very same job. That's what we call 'guaranteed production,'" said the inventor. Just who were included in the "we" was not explained.

The lock washer and nut itself was also a novelty. It was guaranteed to stay on, yes, even to tighten up a bit at times. It was well that the company failed before the customers had fully acquainted themselves with all the good qualities of the nut, for while the nuts could be turped either way on bolts held in the hand, it was an utter impossibility to unscrew them when set up against a surface, for the only release was from the inner face of the nut.

¹Address: Box 157, Middletown, N. Y.

Feed for Diameters and Quickly Obtained

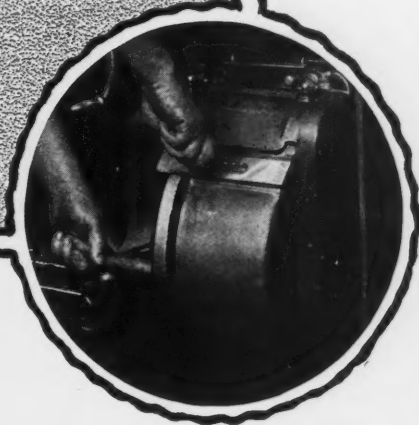
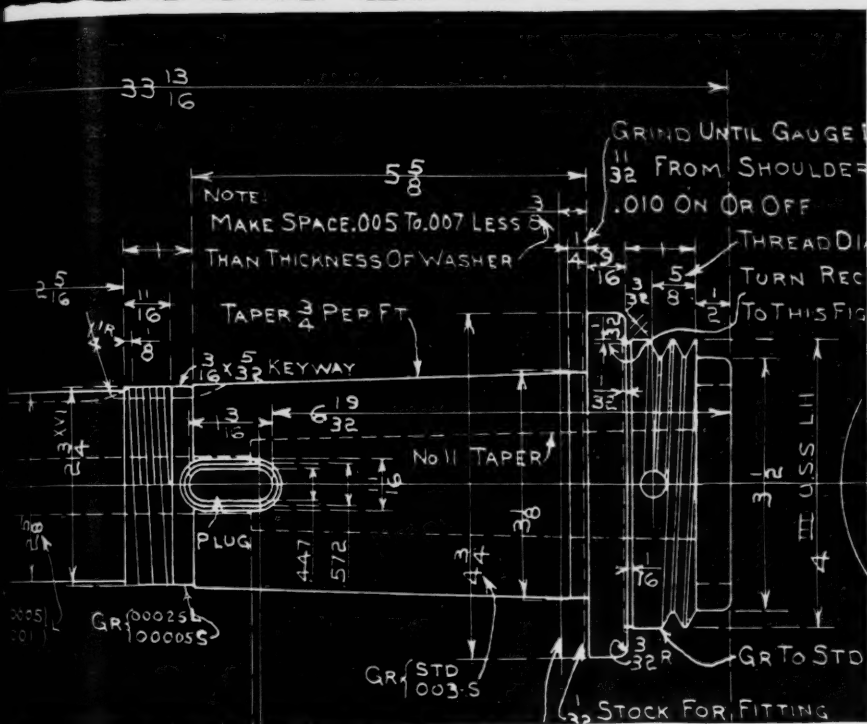


Table Feed Change Levers



MANUFACTURING AUTOMOBILE STEERING POSTS

BY P. J. VISCO¹

A large number of automobile steering posts, as shown at A, Fig. 1, were made from seamless steel tubing, and at one end it was necessary to turn down the tubing from 2 1/16 inches to 1 1/8 inch in diameter. It was not feasible to rotate the tube on the tailstock center on account of the small amount of surface at the end of the post which made it impossible to get truly cylindrical work. So a special center B was made. This center was hardened and ground all over, and was composed of three parts: the body, the ball-thrust bearing, and the 60-degree, conical-shaped part that revolved on the body. The conical-shaped part was corrugated, thus making certain that it turned on the body and not that the tube turned on it. The first center made did not have any thrust bearing and it became red-hot from the friction, due to the expansion of the tube.

The length of these tubes was approximately four feet and they were turned on a "Lo-Swing" lathe with one traverse of the carriage, as three tools were used—two for roughing and one for finishing. A roller follow rest was also used.

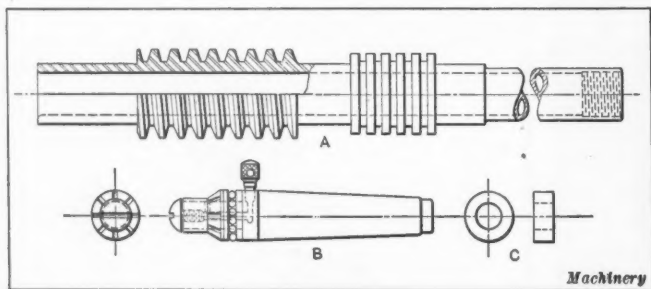


Fig. 1. Steering Post and Special Center for holding on Lathe

Although a coolant was copiously supplied, the tube got hot, expanded and crushed the balls in the bearing so that it was necessary to find some way to hold the post. A wooden washer C was made to replace the ball bearing; after these washers became glazed they gave no trouble.

The triple thread on the posts and the series of grooves to the right of these threads were cut on thread milling machines. These grooves are used to take the end thrust of the post and therefore had to be cut within close limits. After trying several methods with various results, a set of cutters, as shown in Fig. 2, was made, consisting of seven high-speed cutters and five machine-steel washers, carefully surface-ground and lapped so that when assembled the entire cutter measured within 0.0005 inch, this being the allowed limit. This cutter was placed on the spindle of the thread-milling machine and after making sure that the cutters ran true, the carriage of the machine was disengaged so that the work would revolve without traveling forward or backward. The cutters were sunk into the posts to the required depth, and the work was given a complete revolution, the result being a satisfactory job. Lard oil was found suitable for this operation.

¹Address: 570 N. Main St., Springfield, Mass.

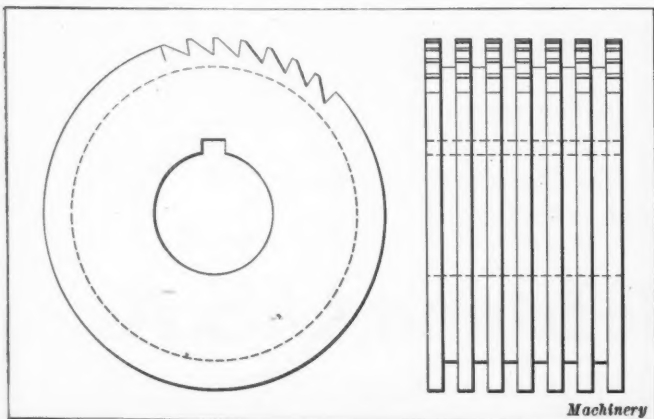


Fig. 2. Tool for cutting Grooves on Steering Posts

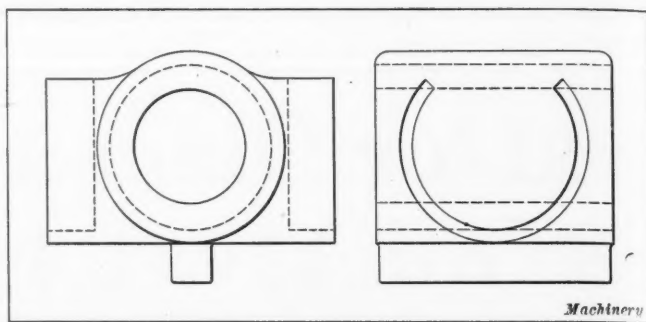


Fig. 3. Steering-post Nut

One end of the posts is threaded internally to a depth of about 3/8 inch. These threads were chased in a lathe and a 1-inch, 14-pitch tap (United States form) was used to size them, until a description was read in MACHINERY of the Gun tap made by the Greenfield Tap & Die Corporation. Then the tap used was ground as nearly as possible to the shape of the tap described, which saved the time necessary for chasing. This tap performed satisfactory work, whereas the ordinary tap sometimes seized the work and spoiled the threads.

The chasing of the triple thread in the steering-post nut, Fig. 3, was quite a problem, as the material was very tough and it was necessary for the thread to fit well on the post. After experimenting with taps it was concluded that the thread should be chased on a lathe, but indexing for each thread was too expensive, so the triple chasing tool, shown in Fig. 4, was made. The chasing tool A was made of a piece of carbon steel that fitted well into a bar B and was held securely by two taper pins. The tool was then turned to a diameter of 1 11/16 inch, after which the three teeth were generated on a thread miller in the same manner as when cutting any other thread. The tool was then taken out of

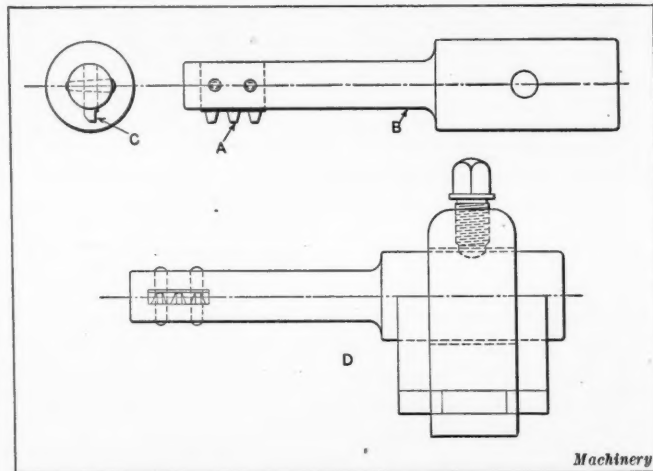
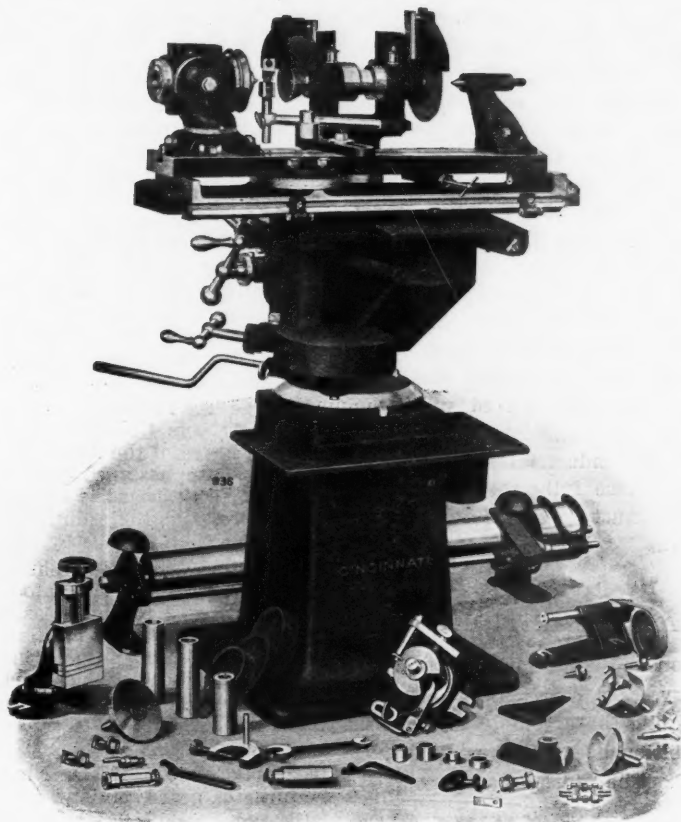


Fig. 4. Tool for cutting Thread in Steering-post Nut

the bar and some material shaped off the top so as to bring the cutting edge as near the center of the holder as possible, and the cutting edge at C filed back by hand. The tops of the teeth were shaped at right angles to the sides. The pitch diameter of the steering post was different from that of the chasing tool, so when the teeth were generated the head angle of the machine had to be set differently than for the thread on the steering post. The assembly of the toolpost is shown at D, the center piece being made so as to fit in the T-slot of the compound rest and bored 1/8 inch larger than the bar, the two side pieces on which the bar rests being bored the size of the bar and the required height so as to align the bar with the center of the lathe. These nuts were chased on an ordinary engine lathe that did not permit the disengagement of the carriage from the lead-screw and the return preparatory to taking another chip. So a lead-screw and a split nut having the same lead as the thread to be cut, but of suitable dimensions, were made. The lead-screw of the lathe was then replaced by this special lead-screw. This made certain the correct engaging of the threads and of course dispensed with the belt shifter. After chasing these nuts, a tap was run through them for sizing.

CLEARANCE



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You wouldn't think of using lathe tools with the wrong clearance. On milling cutters correct clearance is even more important. Incorrect cutter clearance will reduce the output of your milling machines as much as twenty per cent.

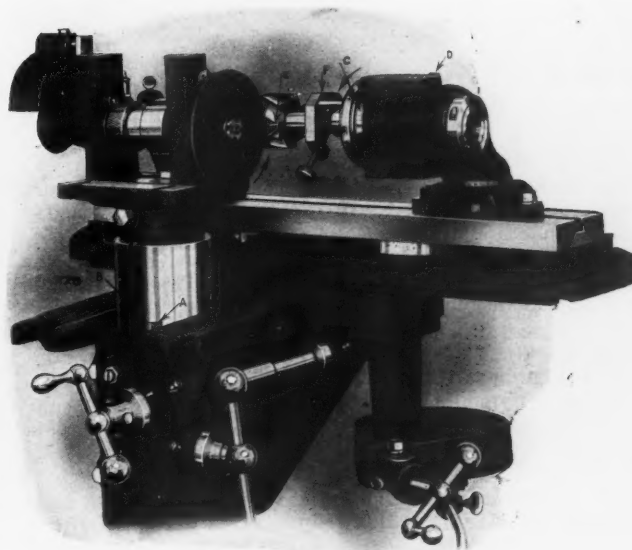
Clearance depends upon certain mathematical relations between the cutter and the grinding wheel.

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JANUARY MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

In a paper on "The Relation of Manufacturing to Banking and Research" read by Walter Rautenstrauch, professor of mechanical engineering at Columbia University, before the January meeting of the New York Section of the American Society of Mechanical Engineers, special emphasis was placed upon the necessity for a closer cooperation between the banking, manufacturing and engineering interests. Continued development in the manufacturing and engineering field will require increased banking facilities, and this, in turn, necessitates that bankers either directly or indirectly acquire a more thorough understanding of the principles of manufacturing and engineering, so that they may thoroughly appreciate the problems laid before them by manufacturers. The latter, in turn, must be made to appreciate more thoroughly the value of engineering and research in promoting their business. In the discussion, an example was cited of the experience of one well-established concern whose production had been increased nearly 70 per cent by the use of experts to do research work, while the overhead cost and the number of men employed had been decreased. Emphasis was also placed upon the necessity of broadening the scope of engineering education so that the young man passing into industrial life from college will be able to comprehend more fully the commercial requirements and limitations that must be considered in connection with engineering problems.

* * *

A TRADE JOURNAL EXHIBITION

An exhibition of about one thousand trade journals is being held in the Library Art Gallery, Newark, N. J., under the direction of the Newark Free Public Library and the Newark Museum Association. The exhibition opened January 13 and will continue until February 12. The journals are arranged on sloping screens, presenting an attractive appearance and making it possible to see the papers clearly and handle them easily. Exhibitions of this kind are, no doubt, of great value in industrial centers, as they make it possible for men engaged in business and the trades to compare the various journals in their field and make a survey of the many trade and technical journals published.

PERSONALS

R. J. Morgan, formerly supervisor of sales for the American Steel Export Co., Woolworth Bldg., New York City, has been appointed assistant general manager of sales.

Henry M. Shaw, for several years connected with the sales department of Sherritt & Stoer Co., Inc., is now associated with the Monarch Machinery Co., Philadelphia, Pa.

D. H. Macdonald, of the sales department of Young, Corley & Dolan, Inc., 115 Broadway, New York City, has been made general sales manager of the machine tool department.

C. P. Coleman was elected president of the Worthington Pump & Machinery Corporation, 115 Broadway, New York City, at a meeting of the board of directors held December 31.

C. Harper Halfmann, formerly sales manager of Slocum, Avram & Slocum Laboratories, Inc., New York City, is now in charge of sales in the small tools department of Young, Corley & Dolan, Inc., 115 Broadway, New York City.

Robert L. Arms, for several years connected with the sales departments of Manning, Maxwell & Moore and Sherritt & Stoer Co., Inc., is now sales manager of the Monarch Machinery Co., Philadelphia, Pa.

Charles A. Swan, formerly superintendent of the Becker Steel Co. of America, has joined the sales organization of the Hess Steel Corporation, Baltimore, Md., and will represent the company in the Cleveland and Detroit territory.

Fred J. Miller, recently assistant to the president of the Union Typewriter Co., New York City, and formerly editor of the *American Machinist*, has been given a commission as major in the Ordnance Reserve Corps, and has been assigned for duty at the Rock Island Arsenal.

Charles Spalding, who had charge of the sales for the Gisholt Machine Co. in the Detroit and Michigan districts, resigned to become general manager of the Amalgamated Machinery

Corporation, Chicago, Ill. Mr. Spalding had been connected with the Gisholt Machine Co. for twelve years.

Nelson P. Hall has been made district sales manager for the Chicago territory of the Van Dorn & Dutton Co., Cleveland, Ohio, and will devote especial attention to the gear and pinion requirements of electric railways and mines in the Chicago field. Mr. Hall will occupy offices at 14 E. Jackson Blvd., Chicago, Ill.

P. C. Gunion has been made advertising manager of the industrial bearings division of the Hyatt Roller Bearing Co., Newark, N. J. Mr. Gunion has been in the sales department of the Hyatt Roller Bearing Co. for two years. Just previous to his appointment as advertising manager, he was manager of the Pittsburgh office.

D. Gleisen, formerly assistant manager in charge of bushings sales with the Hyatt Roller Bearing Co., Newark, N. J., has been made manager of the industrial bearings division of the company. Mr. Gleisen is a graduate of Stevens Institute of Technology and has been connected with the Hyatt Roller Bearing Co. for the past six years.

George A. Lautz will discontinue his active and financial connection with the Niagara Machine & Tool Works, Buffalo, N. Y., about the end of February. Mr. Lautz has been general manager of the firm for twenty-seven years and president for about ten years. He expects to take a much-needed rest, and has not yet formulated his plans for the future.

George S. Thompson, Paris representative of the Vulcan Steel Products Co., Inc., was recently appointed to the purchasing board of the American Expeditionary Forces in France. He has been assigned particularly to the handling of steel matters. This board is composed of American civilians living in France, and their duties consist of passing upon all purchases made in Europe by the American Army.

Franklin T. Chapman has become assistant general sales manager of E. F. Houghton & Co., Philadelphia, Pa. Mr. Chapman was formerly assistant to the manager of the Olympian Motors Co., Pontiac, Mich., and has had a wide experience in the manufacturing field, particularly in the automobile industry. He succeeds W. Burton Piersol, who has become assistant general manager of the Bethlehem Shipbuilding Corporation.

Milton Rupert has been elected vice-president and assistant treasurer of the R. D. Nuttall Co., Pittsburg, Pa., manufacturer of gears, pinions and trolleys. Mr. Rupert has been with the R. D. Nuttall Co. since 1893. In 1903 he was appointed head of the general offices, being directly in touch with all office matters and manufacturing operations. He was later made assistant to the president and general manager. In his new position, Mr. Rupert will have charge of sales and manufacturing activities.

Arthur N. Talbot, professor of municipal and sanitary engineering at the University of Illinois, has been elected president of the American Society of Civil Engineers for the coming year. Prof. Talbot also has charge of the departments of theoretical and applied mechanics at the university, and under his direction laboratories for testing the strength of materials and for hydraulic tests have been developed. In 1913-1914 he was president of the American Society for Testing Materials.

Guy E. Tripp, previously chairman of the Westinghouse Electric & Mfg. Co., has been appointed by the War Department as chief of the production division of the Ordnance Department, intrusted with the task of supervising and stimulating the production of all ordnance supplies, and has been given a commission as colonel. Mr. Tripp was selected because of his experience in the manufacture of munitions of all kinds.

OBITUARIES

F. A. Driver, for many years a director of the Driver-Harris Co., Harrison, N. J., died January 21, aged eighty-two years. Mr. Driver was identified with the Driver-Harris Co. ever since it was formed.

JOHN RIDDELL

John Riddell, mechanical superintendent of the Schenectady Works of the General Electric Co., died in Schenectady, December 31, 1917, aged sixty-five years. Mr. Riddell was born in Ireland, and at the age of twelve was apprenticed in a jobbing machine shop in Jersey City owned by Nicholas B. Cushing, who made elevators and repaired machinery, especially marine engines. Even as an apprentice, his employers selected him to handle some special marine engines that they were repairing, because of his remarkable aptitude for the work. The work brought him in contact with seafaring men, and he spent two years as second engineer on trading steamers plying between the West Indies and Central America and New York.

His first association with the electrical business was with the Daft Electrical Co., where he was rated as a machinist, but was really doing experimental mechanical work, especially

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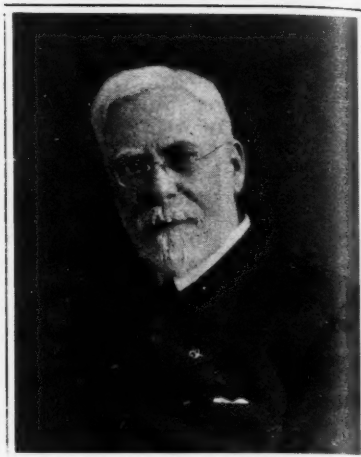
CLEVELAND, O., U.S.A.

in the railway field. In 1887 he entered the employ of the Thomson-Houston Electric Co., at Lynn, Mass. In 1888 he became foreman of the railway motor shop and was recognized as one of the leading mechanical experts at the time the General Electric Co. was formed in 1892. He moved to Schenectady in 1895, and shortly after his arrival was appointed mechanical superintendent. In this important position he designed special machine tools for increasing the production of the machine shops and also for carrying on the many special processes involved in the manufacture of electrical machines. Many of these machine tools were built by the General Electric Co. under his direction; and for such tools as were purchased outside, Mr. Riddell not only prepared the specifications, but actually purchased them himself as the company's representative. He was consulted in regard to all automatic machinery and was called upon when a solution was sought for different mechanical problems that baffled the average expert.

The records of the United States Patent Office show that thirty-seven patents were taken out in the name of John Riddell. There are hundreds of improvements on machine tools which he either invented or regarding which his opinion was sought by manufacturers in various lines. Frequently designing engineers of machine tools have taken journeys to Schenectady to show Mr. Riddell a suggested machine tool improvement and ask his opinion, criticisms and suggestions. Among the notable achievements of Mr. Riddell in the various works of the General Electric Co. is a boring mill—the largest in the world at the time—which was built from his design and which has a sixty-foot swing. This was so successful for machining the large wheels for the rotors and stators of water-wheel-driven generators that he designed a forty-foot boring mill embodying the same principles as the large one and used for turbine work. Another one of his machines was the bucket-cutting machine for large steam turbines which he

developed in 1902. It was at this time that the General Electric Co. was building the first 5000-kilowatt steam turbine ever constructed, and this labor-and time-saving device became an important factor in the development of the steam turbine industry at the time when the steam engine was pre-eminent in the largest power plants in the world. Almost automatic was the field-coil winding machine which he built and which was adopted both in Lynn and Schenectady. In the opinion of many, there was no single achievement of Mr. Riddell's which advanced the electrical industry more than this winding machine.

Mr. Riddell was a member of the American Society of Mechanical Engineers, the Engineers' Club of New York, the Society of Engineers of Eastern New York, the General Electric Quarter Century Club, and of several other clubs and societies. He delivered several papers on engineering subjects before various associations. He was awarded a gold medal at the Panama-Pacific Exposition in San Francisco in 1915 as collaborator in the exhibit of the General Electric Co. He leaves a widow and a daughter, Mrs. William Newcomb.



John Riddell

COMING EVENTS

February 28—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

April 18-20—National Foreign Trade Council conference in Cincinnati, Ohio; Gibson Hotel, headquarters. Secretary, O. K. Davis, 1 Hanover Square, New York City.

April 24-25—Annual convention of the National Metal Trades Association at the Hotel Astor, New York City. Homer D. Sayre, secretary, 1021 Peoples Gas Bldg., Chicago, Ill.

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers' Association, F. D. Mitchell, Woolworth Bldg., New York City.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburgh, Pa., secretary.

SOCIETIES, SCHOOLS AND COLLEGES

Lowell Textile School, Lowell, Mass. Quarterly bulletin 1917-1918 giving a list of the names and addresses of the graduates and undergraduates of the school who are in military service and the branch of service which they have entered.

University of Illinois, Urbana, Ill., announces that the university maintains fourteen engineering experiment station research fellowships and that one other such fellowship has been established under the patronage of the Illinois Gas Association. These fellowships, for each of which there is an annual stipend of \$500, are open to graduates of approved American and foreign universities and technical schools. They are for two consecutive college years, at the expiration of which period, if all requirements have been met, a degree of master of science is conferred. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

NEW BOOKS AND PAMPHLETS

Electric Pumping. By H. W. Wagner. 80 pages, 6 by 9 inches; 17 illustrations. Published by the Engineering Experiment Station, Iowa State College of Agriculture and Mechanical Arts, Ames, Iowa, as Bulletin No. 46.

Determination of Absolute Viscosity by Short-tube Viscometers. By Winslow H. Herschel. 55 pages, 7 by 10 inches. Published by the Government Printing Office, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 100. Price, 10 cents.

The Modern Gasoline Automobile. By Victor W. Page. 1032 pages, 5½ by 8½ inches; 725 illus-

trations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, \$3.

The seventh edition of this treatise on the construction, operation, and maintenance of gasoline automobiles has been revised and enlarged. It contains additional material relating to ignition, the action of generators and the basic principles on which they operate, different types of tractors, cycle cars, the combination gasoline-electric drive, a discussion of ball and roller bearings, the latest types of gasoline and kerosene carburetors, and other important developments.

Motion Picture Education. By Ernest A. Dench. 353 pages, 5 by 7½ inches. Published by the Standard Publishing Co., Cincinnati, Ohio. Price, \$2.

This book relates to the value of moving pictures in education, and deals with many of the important services that may be rendered by the educational film. While not intended specifically to convey any information relating to the use of moving pictures in the study of mechanics and engineering, except for a brief section relating to the industrial uses of the motion picture, the book, nevertheless, suggests how moving pictures might be well employed to an increasing extent both for engineering and industrial education. In addition, it gives some interesting information relating to the methods by means of which motion pictures are made.

Precision Grinding Machines. By Thomas R. Shaw. 214 pages, 5½ by 8½ inches; 164 illustrations. Published by D. Van Nostrand Co., 25 Park Place, New York City.

This book deals with grinding machines used for manufacturing purposes, omitting tool and cutter grinders, which belong to another class. The various types of machines and their uses are first described, after which grinding wheels and methods of grinding are taken up. The book is divided into twelve chapters dealing with Importance and Advantages of Grinding; Cylindrical Grinding Machines; Plane Surface Grinding Machines; Bed and Table Construction; Driving Arrangements; Reversing Mechanism and Automatic Feed; Wheel-head; Work-heads and Tailstocks; Work-holding Devices; Profile and Form Grinding; Grinding Wheels; and Care and Operation of Grinding Machines. In order to make the reader more familiar with grinding machines, photographs of representative machines are shown and a number of line illustrations of various grinders are included, showing the construction of the principal mechanisms. The theory of grinding, on which there is much difference of opinion, has been purposely omitted. The book should be of interest both to designers and users of grinding machines.

Steam Power Plant Engineering. By George F. Gebhardt. 1057 pages, 6 by 9 inches; 640 illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, \$4.

This is the fifth edition of Gebhardt's well-known work on steam engineering. The same treatment of the subject has been followed in this edition as in those previously published, but the book is practically a new one and has been greatly increased in volume. Particular emphasis has been placed upon the subject of fuels and combustion, and supplementary chapters on elementary thermodynamics, properties of steam, and properties of dry and saturated air have been added. The scope of the work having been greatly enlarged, the entire text has been rewritten and reset with the exception of a few minor sections. The work is divided into twenty-five chapters headed as follows: Elementary steam power plants; fuels and

combustion; boilers; smoke prevention; superheaters; coal and ash handling; chimneys; mechanical draft; reciprocating steam engines; steam turbines; condensers; feed water purifiers and heaters; pumps; separators, traps, drains; pipe fittings; lubricants and lubrication; testing and measuring apparatus; cost of power; specifications; typical central stations; typical modern isolated stations; properties of steam; elementary thermodynamics; properties of air.

Eye Hazards in Industrial Occupations. By Gordon L. Berry, field secretary, National Committee for the Prevention of Blindness, with the cooperation of Lieutenant T. P. Bradshaw, formerly technical assistant to the director of the American Museum of Safety. 150 pages, 6 by 9 inches; 49 illustrations. Published by the National Committee for the Prevention of Blindness, 130 E. 22nd St., New York City. Price, 50 cents.

In this volume the author reviews the chief industrial hazards to eyesight in the industries of the United States. Case reports illustrate each section; the special dangers are described and recommendations made for such changes of working conditions or installations of protective devices as have been found effective for protecting workers. The following section headings indicate the scope of the book: Statistics of Eye Accidents; Chipping Operations; Machine Operations; Abrasive Wheels; Sand-blasting; "Mushroomed" Tools; Riveting; Radiations from Intense Light and Heat Sources; Ultra-violet Rays in Illuminants; Radiant Energy in Arc-welding and in Molten Metal; Metallurgical Operations; Glassblowers' Cataract; Infections; Gage Glasses; Acids and Chemicals; Treatment of Acid Burns; Industrial Poisons; Removal of Dangerous Fumes, Vapors and Gases; Spray Process Hazards; Methyl Alcohol; Bottling Accidents; Mining and Quarrying; Agricultural Hazards; Goggles; Garment Trade Hazards; Industrial Lighting; and the Safety Movement.

NEW CATALOGUES AND CIRCULARS

Link-Belt Co., Chicago, Ill. Catalogue 299, treating of the application of Link-Belt silent chain in rubber mill machinery.

Aluminum Castings Co., Cleveland, Ohio. Circular of Lynx bronzes. Also reprint of an advertisement of Lynx bronze gears that appeared in MACHINERY for January.

Gisholt Machine Co., 1201 E. Washington Ave., Madison, Wis. Circular of Gisholt universal tool grinder, containing illustrations showing step by step the operations in grinding tools.

Fafnir Bearing Co., New Britain, Conn. Catalogue treating of the application of Fafnir ball bearings in pleasure cars and pointing out the advantages of this type of bearing for this particular line of service.

Sherman Service, 10 State St., Boston, Mass. Booklet entitled "Industry, Society, and the Human Element," describing the various activities of the Sherman Service in cases of industrial disputes and strikes.

Fitchburg Grinding Machine Co., 76 Winter St., Fitchburg, Mass. Circular of Fitchburg 6 by 20-inch hand-operated plain grinding machine with a capacity for work up to three inches in diameter and twenty inches in length.

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TRADE NOTES

L. S. Starrett Co., Athol, Mass. Catalogue entitled "The Tools Mechanics Buy," treating of methods of setting Starrett micrometers, verniers, calliper squares, height gages, dividers, surface gages, rules, tapes, screw-pitch gages, drill gages, wire gages, hacksaws etc.

Titanium Bronze Co., Inc., Niagara Falls, N. Y. Circular descriptive of T B C phosphor-bronze castings, pointing out the essentials of a high-grade phosphor-bronze. Specifications are given for a phosphor-bronze for gears and one for bearings that are used by this company.

Martin Machine Co., Greenfield, Mass. Circular of the Martin No. 12 marking machine designed for marking trade name, size or patent marks on all round or flat surfaces of tools or similar work. The machine is operated hydraulically, giving a smooth and even movement.

Lincoln Twist Drill Co., Taunton, Mass. Booklet describing the group insurance plan that the company put into effect beginning January 1. Copies of the booklet were distributed to the employees at Christmas to announce the insurance plan that will be put into effect without cost to them.

National Scale Co., 2 Mechanic St., Chicopee Falls, Mass. Catalogue of National counting and weighing machines, National-Chapman elevating trucks, National calling system and "multi-unit" sectional steel shelving. The catalogue is printed in two colors and illustrated with excellent halftone and line engravings.

Reynolds Machine Co., Massillon, Ohio. Catalogue E, illustrating Reynolds screw-driving machines for driving wood or machine screws by power. It is claimed that one of these machines replaces from three to six hand operators, driving from 8000 to 16,000 screws per day, according to the class of work and the dexterity of the operator.

L. S. Starrett Co., Athol, Mass., is distributing two pamphlets entitled "Building a Business" and "Essentials to Success." The former contains the autobiography of L. S. Starrett and a brief account of the invention and development of some of the Starrett tools. The other pamphlet also contains a collection of incidents from the life of L. S. Starrett.

L. F. Grammes & Sons, Allentown, Pa. Circular of safety devices including circular saw guards, hand jointer guards, shaper guards, grinding wheel hoods, eye protectors, press guards, gage glass protectors, safety oil-cans, protective gloves, shoes, etc., safety flanges for emery wheels, safety respirators, first-aid outfits and many other safety devices.

Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. Circular illustrating Oliver universal saw bench, single-cylinder surfacer, universal vertical and horizontal boring machine, hand planer and jointer, disk sander, heavy-duty engine lathe, tool-room engine lathe, motor-head speed lathe, universal and wood milling machine and other woodworking and metal-working machines.

Precision Truing Device Co., 519 Main St., Cincinnati, Ohio. Booklet illustrating and describing a grinding wheel for truing grinding wheels. The device is a self-contained electrically driven machine that drives a small wheel of hard abrasive at a peripheral speed of about 8000 feet per minute. This high-speed wheel is moved back and forth across the face of the wheel to be trued the same as a diamond.

Bacharach Industrial Instrument Co., 422 First Ave., Pittsburg, Pa. Catalogue E, describing "Hydro" gas meters. A review is given of the various methods employed for measuring gases, such as impact and pitot tubes, orifices, nozzles, venturi tubes, etc. A detailed description of the "Hydro" instrument, which measures and records the differential pressure, is included. This instrument is made portable for the use of the testing engineer and the efficiency expert.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 8-E, treating of Westinghouse industrial electric heating apparatus, including steel-clad heaters, immersion type water heaters, stoves of various forms, electric oven heaters for use in enameling, etc. Several pages are devoted to the subject of electrically heated ovens covering design and construction, a discussion of the various types and their uses, and the efficiency that can be secured in operation. Westinghouse electrical heaters of the ribbon type are described, as well as the Westinghouse system of thermostatic control.

Fafnir Bearing Co., New Britain, Conn. Catalogue 17, containing a discussion of the principles relating to the application of ball bearings to machinery. The book is divided into two sections, the first containing an analysis of the loads carried by ball bearings and dealing specifically with the design of the Fafnir radial type of ball bearing. This section is illustrated with blueprints and detailed line drawings. The second section illustrates machines equipped with Fafnir ball bearings, among which are drilling machines, chucking machines, screw machines, automatic lathes, turret lathes and grinding machines.

Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa., each year prints and distributes about twenty-three different publications. Most of these publications are written for technical readers and discuss in an educational way the products of the company that are adapted to the particular field in which the reader is most interested. None of these publications deals with all the products of the company, and to supply the need in non-technical language of a general description of the chief products, a pamphlet entitled "My Dear Jim" has been printed. This is in the form of a letter from a retired steel man to a friend, and it gives a comprehensive statement of the products of the company.

Vixen Tool Co. has moved from Philadelphia, Pa., to 865 Mt. Prospect Ave., Newark, N. J.

W. B. Knight Machinery Co., St. Louis, Mo., has moved from 2019 Lucas Ave., to its new factory at 3920 W. Pine Blvd.

Ott Grinder Co., Indianapolis, Ind., had its plant destroyed by the fire which, on January 13, burned down the Industrial Building in Indianapolis.

Walworth Mfg. Co., Boston, Mass., has opened a branch office at Seattle, Wash., which will be in charge of Thomas Nickerson.

Wagner Electric Mfg. Co., St. Louis, Mo., has removed its Seattle office to 535 First Ave., S., where a service station will also be maintained. C. Kirk Hillman will continue in charge.

W. K. Millholland Machine Co., Indianapolis, Ind., had its plant destroyed by fire January 13, together with thirty other industries which suffered a total loss by the burning of the well-known Industrial Building.

Bowen Products Corporation is the successor of the Winkley Co., manufacturer of grease- and oil-cups. The company will be located in the same quarters at 866 W. Warren Ave., Detroit, Mich.

Pangborn Corporation, Hagerstown, Md., is making plans for the erection of a foundry 150 by 100 feet, an extension to its machine shop of 100 by 60 feet, and a wood shop 60 by 40 feet. The construction will be of steel and brick with metal sash.

Boston Scale & Machine Co., Boston, Mass., whose factory was destroyed by fire on December 23, asks the indulgence of its customers, as some delay must necessarily ensue in filling orders. All orders will be filled, however, with as little loss of time as possible.

Pangborn Corporation, Hagerstown, Md., manufacturer of sand-blast equipment, presented its employees last Christmas with life insurance policies ranging from \$500 to \$1000, according to length of service. The Pangborn Corporation bears all expense of maintaining the insurance.

Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill., at its annual meeting of the board of directors, elected the following officers for the ensuing year: President, T. K. Webster; vice-president, L. I. Yeomans; secretary, Walter A. Strong; treasurer, C. M. Moderswell.

New Standard Hardware Works, Mount Joy, Pa., manufacturers of hardware specialties, have made an addition to their plant and organization for the hot-tinning of gray iron, malleable iron, steel and brass stampings, and are now in a position to take care of increased quantities of hot-tinning work.

Driver-Harris Co., Harrison, N. J., announces that it is now prepared to supply 99 per cent cold-rolled pure nickel sheets to manufacturers who are interested in the use of this metal. Many former uses for this metal have been abandoned, due to the inability of manufacturers to secure the necessary raw material.

W. J. Baird Machinery Co., Detroit, Mich., dealer in new and second-hand machine tools and also supplies, has outgrown its old quarters at 54-56 E. Jefferson St. and removed to 265-269 E. Jefferson St. The company will occupy the entire building, which will provide excellent facilities for displaying its large line of tools.

Queen City Machine Tool Co., Cincinnati, Ohio, manufacturer of plain cylindrical grinding machines and back-gear crank shapers, has inaugurated a system of rewarding regular attendance in the shop by presenting thrift saving stamps to the men who meet certain requirements for a given period.

Gisholt Machine Co., 1201 E. Washington Ave., Madison, Wis., has made agency sales arrangements with the Charles A. Strelinger Co., 43 E. Larned St., Detroit, Mich., to look after the sale of Gisholt machines in the Detroit and Michigan districts. Charles Spalding who heretofore had charge of the sales in these districts has resigned.

Simonds Mfg. Co., Fitchburg, Mass., has appointed the T. P. Walls Tool & Supply Co., 75-77 Walker St., New York City, its sales agent for the territory of Connecticut, New York and New Jersey. A complete stock of Simonds hacksaw blades, hand-saws and cold-saws will be maintained in the T. P. Walls Tool & Supply Co.'s warehouse.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, is now occupying its new buildings and the plant is again in operation to its full capacity. New equipment especially adapted for the building of hydraulic presses, pumps and valves has been installed. The new buildings and equipment will double the capacity of the plant.

Vulcan Steel Products Co., 120 Broadway, New York City, dealer in steel, iron and machinery products, by its association with the Othophon Steamship Corporation is assured direct service to Brazil and the Argentine. Favorable connections with other railroad and shipping interests secure the most prompt deliveries to all other countries.

Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill., has secured a \$750,000 order for gun boring machines and lathes, and a \$500,000 order for shell boring machinery. With its present capacity of turning out ten machines a day, the plant is in a position to handle these large orders as well as additional ones and still assure a thirty-day delivery.

Victor R. Browning & Co., Mansfield, Ohio, have recently been awarded a contract for 200 five-inch gun mounts by the Navy Department, and are in the market for a large supply of small and large

size machine tools, including lathes, vertical and horizontal milling machines, radial drilling machines, grinding machines and shapers. The company would also like to hear from manufacturers who are making parts, both raw and finished products, for gun mount construction.

American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill., has been incorporated in Illinois for the manufacture of air chucks and air-operated devices for mechanical purposes. John Olson, formerly with the Detroit Pneumatic Chuck Co., will be in charge of design and manufacture. The company will specialize for the present in standard and special air-operated equipment for the rapid production of shells and other munition parts. Later it is the intention to place on the market a complete line of air chucks. Neldow & Payson Co. of Chicago has been appointed selling agent.

Deane Machine Co., Fitchburg, Mass., maker of machine tools, jigs, fixtures, tools, etc., has recently been incorporated. The officers are John H. Graves, president and general manager; A. P. Cate, treasurer; and William P. Coyle, secretary. Mr. Graves and Mr. Coyle were formerly connected with the Putnam Machine Co., and have had wide experience in the machine tool trade. The company is at present engaged on two contracts for the government and is seeking a site for a larger plant, and is prepared to do general repair and contract work.

Driver-Harris Co., Harrison, N. J., announces that on January 1 a life insurance policy for \$500 was distributed to all employees having been with the company at least six months. The extra wage distribution for this year was also increased by one per cent over what has heretofore been paid. This distribution is based on salaries earned and terms of service, and is made twice yearly. The percentage is graduated, beginning at 6 per cent to employees who have been with the company six months, and increasing by one-half per cent for each succeeding year of continuous service.

Louisville Industrial Foundation, 909 Columbia Bldg., Louisville, Ky., has made an announcement of interest to manufacturers of war materials, to the effect that the Louisville central station has at this time more than 10,000 kilowatts surplus electric power for industrial service, and is one of the few cities in the United States having electric power in excess of the present demand.

Little Giant Truck Co. is a new organization which has been formed to take over the motor truck interests of the Chicago Pneumatic Tool Co. From a small beginning the motor truck department of the Chicago Pneumatic Tool Co. had grown to such proportions that a separate organization to handle its many interests became absolutely necessary. The Little Giant Truck Co. is owned and controlled by the Chicago Pneumatic Tool Co., and the officers are the same, viz., W. O. Duntley, president; W. B. Seelig, secretary; L. Beardsley, treasurer; and T. J. Hudson, sales manager. The headquarters will remain in the Little Giant Bldg., 1615 Michigan Ave., Chicago, Ill.

Root & Van Dervoort Engineering Co., E. Moline, Ill., is a consolidation of the Moline Automobile Co., maker of Moline-Knight motor cars, and the Root & Van Dervoort Engineering Co., maker of R. & V. gasoline and kerosene engines. The officers and management remain the same, the only change being in the name of the company. In the past these two companies have been practically identical, being under the control of the same general officers, but were operated under the two firm names. The Root & Van Dervoort Engineering Co. was established in 1898 to manufacture gasoline and kerosene engines. In 1916 the company branched out into the manufacture of special munition lathes, and also filled a large contract on 8-inch high-explosive shells for the British government.

Oesterlein Machine Co., Cincinnati, Ohio, manufacturer of milling machines and cutter and tool grinders, has purchased the buildings of the Samuel C. Tatem Co. on Colerain Ave., Cincinnati, Ohio, consisting of a four-story and basement concrete building 60 by 266 feet, a one-story building 103 by 300 feet, and also a separate power house. The ground acquired covers 270 by 480 feet and has a spur from the main track of the Baltimore & Ohio Railroad. The building, which is only a few years old, is patterned after the Dayton Cash Register Co.'s buildings at Dayton, Ohio, and is light, airy, and sanitary; it is considered one of the most up-to-date manufacturing plants in Cincinnati. The floor space of the Oesterlein Machine Co. will be considerably greater in the new buildings than in the old location, providing an opportunity for expansion and increase in capacity.

U. S. Ball Bearing Mfg. Co., Palmer St. and Kolmar Ave., Chicago, Ill., manufacturer of ball bearings, at the last meeting of the board of directors elected the following officers: W. H. Strom, president and treasurer; E. N. Strom, vice-president; and G. A. Strom, secretary. The change in officers was brought about by the recent death of A. A. Strom, father of the three members of the present board, who, during his life, was president of the company, but who was associated with it in an advisory capacity only. No actual change in management has taken place, as the present president retains his position as general manager, which he has occupied for the past five years. Previous to Mr. Strom's death, it had been decided by the active members of the company that, in recognition of Mr. Strom's successful activities, the name of the product of the company should be changed from "U. S. ball bearings" to "Strom bearings," and one of the last official acts performed by the late Mr. Strom in his advisory capacity with the company was to sanction the change of name as planned. At the annual meeting, appropriations for a considerable increase in the capacity of the present plant were made.